General Report
of the
Topographical Survey of India
1871-72, 1873-74, 1876-77
&
1877-78

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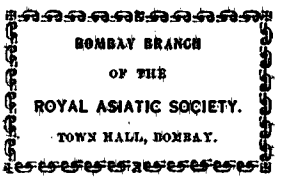

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GENERAL REPORT

ON THE

Topographical Surveys of India,

AND OF THE

SURVEYOR GENERAL'S DEPARTMENT,

FOR SEASON

1871-72.

BY

COLONEL H. L. THUILLIER, R.A., F.R.S., &c.,

SURVEYOR GENERAL OF INDIA.

134689

SUBMITTED TO THE GOVERNMENT OF INDIA, DEPARTMENT OF AGRICULTURE, REVENUE, AND COMMERCE.

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GENERAL REPORT

OF THE

Topographical Surveys of India,

AND OF THE

SURVEYOR GENERAL'S DEPARTMENT,

FOR SEASON

1871-72.

No. 154 B, dated Calcutta, 15th January 1873.

Introductory.

The general results of the operations of the Topographical Surveys of India, for the professional season of 1871-72, *viz.*, from 1st October 1871 to 30th September 1872, and the progress of work in the several branches of my head-quarters office, for the year ending 31st December 1872, are described as usual in the following report submitted in continuation of my general report, No. 150 B, dated 24th January 1872.

2. The frequency of these reviews of a single operation or description of surveys, carried on year after year on the same principles and with the same officers and men, over vast tracts of territory, which of necessity must occupy a long course of years in the completion, naturally entails much sameness of details and repetition of explanations, for which allowance must be made in the perusal of the history of a department so constantly describing its own proceedings and results. The professional and other details are more given as a necessary and useful record of departmental events, which from thus being strung together and printed annually, may hereafter be found and referred to, with greater certainty and convenience.

Surveys in progress.

3. The number of the Topographical Surveys under my direction has, by the resuscitation of No. 2 Party for Khandesh and Bombay Native States, been again raised to seven, as originally constituted prior to 1870; the prosecution of each field of survey has been carried systematically on towards filling up each degree of blank country in the respective divisions, so as to provide for each sheet of the Indian Atlas in due order. The several executive officers have again pursued their laborious course with equal advantage and success, and were, during the season under review, thus employed:—

No. 1.—Under Lieutenant T. H. Holdich, R. E., Assistant Superintentent Officiating in charge, in portions of the Native States of Gwalior, Holkar's Territory, Kotah, Tonk, Jhalawar and Kurwai, within the limits of the Indore and Rajputana Agencies;

No. 2.—Under F. B. Girdlestone, Esquire, Officiating Deputy Superintendent in Khandesh (Bombay Presidency), and the Native States lying between the Nerbudda and Taptee Rivers of Burwani, Dhar, Holkar and outlying portions of Sindiah's Territory in the Rajputana Agency embracing a continuation of the Sathpura Range, and the completed Surveys of the Central Provinces;

No. 3.—Under Colonel G. H. Saxton, Deputy Superintendent, in portion of Bustar Dependency of the South-Eastern portion of the Central Provinces, and in Jeypur, Panchpenta, Madgul and Vizianagram, in the Vizagapatam Agency of the Madras Presidency;

No. 4.—Under Major G. C. Depree, Deputy Superintendent, in the northern zemindarees of district Belaspur and district Mandlah in the Central Provinces, and in Tolooka Sohagpur of the Rewah State, in continuation of former work in the Chota Nagpur Province.

No. 5.—Under Captain R. V. Riddell, R. E., in Bhopal and Malwa, including portions of Gwalior, Kurwai, Mohamedgurh, Nawab, Basoda, and Pathari in the Indore Agency, in succession to the completed areas in Bundelkund and the Revenue Survey of the Saugor District;

No. 6.—Under Captain W. F. Badgley, Officiating Deputy Superintendent, in the South Cachar, Lushai and Munnipur Hills on the Eastern Frontier of Bengal, advancing under protection of the military expedition, to obtain geographical knowledge of the hitherto unknown territory outside the British districts of Cachar, Sylhet, Tipperah and Chittagong, occupied by various tribes not amenable to British rule;

No. 7.—Under Captain George Strahan, R. E., Deputy Superintendent, in the states of Jodhpur and Udeypur, and the district of Ajmere and Mhairwara within the Rajputana Agency. Also the large scale survey of the Sanitarium of Simla during the recess months.

4. These Surveys thus occupy every variety of ground extending from the extreme eastern limit beyond actual British possessions in Bengal, in about the meridian of 93° east longitude, to the eastern frontier of the Bombay Presidency, in about 74° east longitude, or from Munnipur territory on the east, to Dhoolia and the Western Ghats of Bombay on the west, and down nearly to the Godavery on the parallel of 18° north latitude on the south, the distance between the most eastern and western surveys being nearly 1,300 miles in a direct line.

5. As these surveys progress, the ground to be taken up becomes more insalubrious and difficult of access and occupation, both by reason of physical obstacles, bad climate, and bad water. Without exception almost, the ground now occupied by each party is very wild, much of it altogether uninhabited, and in many parts very hostile to health from malaria. While some parties cannot obtain, except from long distances, water fit for human drink, others have to carry about provisions, even the commonest necessaries of life, throughout the field season, which renders carriage difficult and expensive. In the hills inhabited by Gonds skirting the northern frontier of the Central Provinces, again within the Sathpura Hills, west of British Nimar, and also in the Bheel Country south and west of Ajmere and Mhairwara, even guides are not easily procured and the uncivilised inhabitants whose hamlets are occasionally found within the jungles, fly at the approach of strangers, and will afford no information when surprised and questioned.

6. These are but a few of the difficulties and obstacles which affect cost and progress, and have yearly to be contended against and overcome by the Topographical Surveyors now exploring and surveying in detail, the vast tracts still remaining which have never before come under the regular operations of the Survey Department, or indeed of any survey at all, but all and every corner of which must be penetrated and defined. Yet steadily a marked impression is being made in laying down the features of the country towards completing the first survey of all India, and an area of from 16,000 to 18,000 square miles on an average, is annually mapped by this one branch of the department.

Season's total out-turn of final topography.

7. The area of final survey completed during the season under review is the outturn of only six surveys, as the small nucleus of No. 2 Party could do no more than break ground in Khandesh by laying out the skeleton triangulation in advance, as previously reported, and no detail survey could be attempted. The topography actually obtained represents an area of 17,910 square miles, of which 13,110 square miles are on the inch to the mile scale, or $\frac{1}{63,360}$ of nature, as usual for the regular surveys in the ordinary divisions. Also 4,800 square miles on and beyond the eastern frontier of Bengal on the geographical scale of 4 miles to the inch or $\frac{1}{253,440}$ of nature, which being special, and in no way adapted or required for the former scale, partakes necessarily of the character of a rapid military reconnoissance having been conducted under very exceptional circumstances during the rapid advance of a military force into a hostile country, and achieved only under the protection of a large military force.

Triangulation completed in advance of detail survey.

8. The triangulation extended in advance for the ensuing or current, and future season's detail survey, covers an area of 16,336 square miles in addition to that represented in the previous paragraph; the basis for future topography is, therefore, very well provided for, as so essential for the correct conduct of the operations. This area of the skeleton work performed, although less than that of 1870-71, is considerably in excess of the out-turn of 1869-70.

Total cost of the season's operations.

9. The total cost at which these general results have been obtained amounts, under all heads both of permanent establishments and contingent charges, to Rs. 3,71,616, in the aggregate, as specified under each party, this includes the cost of triangulation in advance and the exceptional charges for the re-equipment of No. 2 survey in tents, tools, stores of various kinds, and railway and conveyance charges of the establishment (European and Native).

Average cost of final survey.

10. The average rate or cost per square mile of topography completed, and mapping rendered by the executives, is for the season Rs. 20-10, or in English money £ 2-1-3 per square mile, which contrasts favorably with the mean rates of the two previous seasons.

Statement of general results.

11. The following statement exhibits the amount and professional nature of the work performed and the actual cost of each survey :—

Designation of Survey.	Final Topography completed in square miles.	Triangulation completed in square miles.	Stations observed at.	Number of points fixed.	Square miles to each point.	Heights (trigonometrically determined.	Square miles to each height.	Amount of fair map-plan produced.	Total cost.	Remarks.
No. 1 Survey.—Gwalior and Central India, ...	2,760	4,200	79	439	9·6	334	12·6	2,990	34,627	
No. 2 Survey.—Khandesh and Bombay Native States ...	...	4,940	137	831	5·9	559	8·4	None.*	37,967	*Triangulation only.
No. 3 Survey.—Central Provinces and Vizagapatam Agency ...	2,033	...	42†	109†	...	99†	...	2,033	62,615	†Points interpolated in the triangulation of the previous seasons.
No. 4 Survey.—North-Eastern Division, Central Provinces ...	2,691	2,100	46	272	6·0	166	12·7	2,691	52,537	Ground very difficult, covered with hills and forest.
No. 5 Survey.—Bhopal and Malwa	3,124	...	...	...	...	...	...	3,124	58,146	No triangulation performed.
No. 6 Survey.—Khasia and Garo Hills, south Cachar and Lushai Hills	4,900‡	2,156	16	116	18·6	65	33·2	4,900	47,073	‡ Military reconnoissance on scale 4 miles=1 inch, also 782 miles of route survey in the Lushai Hills on scale 1 mile = 1 inch.
No. 7 Survey.—Rajputana ...	2,612	2,940	...	...	...	145	20·0	1,590	55,611	21 miles of traverse survey and triangulation for Simla special survey,—17 miles of traverse for the Sambhur Lake survey and triangulation round Delhi.
Total ..	17,910	16,336	333	1,767	..	1,398	...	17,393	3,71,016	Average rate or cost for final survey, Rs. 20-10 per square mile.

Remarks on general results.

12. The general results are good, showing for a slightly increased outlay an increase of area brought under final survey during the season of 3,318 square miles above that obtained during 1870-71, whilst the rate or cost per square mile has been materially decreased.

Comparison of results of 1870-71 *with* 1871-72.

	Final topography.	Triangulation in advance.	Cost.	Average mileage rate.
	Square miles.	Square miles.	Rs.	Rs. A.
Season 1870-71 ...	14,592	20,742	3,24,225	21 4
,, 1871-72 ...	17,910	16,336	3,71,516	20 10
Difference ...	+3,318	−4,406	+47,291	−0 6

13. The decrease in the area triangulated in advance of detail survey is, owing to Nos. 3 and 5 parties having obtained a sufficiency of such points during previous seasons for the plane table operations of nearly the next two years. It is injudicious to extend the triangulation too much in advance of details, because the marks and poles are frequently removed or destroyed by the people of the country, are blown down during the monsoon months, or are obscured by the rapid growth of underwood and jungle, so that, all the labor and cost of clearing sites and erecting marks would have to be incurred a second time.

14. With reference to the area triangulated, the number of points fixed and elevations determined, the results contrast favorably with those of the previous season as shown in the comparative statement.

	1870-71.	1871-72.	Remarks.
Number of stations observed at	450	313*	* No data given by No. 7, Rajputana Survey.
Points fixed Trigonometrically	1,550	1,767*	Interpolated points included in the return of No. 3 Central Provinces and Vizagapatam Agency Survey.
Heights determined Trigonometrically	1,216	1,398	Points of Naga Hills triangulation included in the return of No. 6, Khasia and Garo Hills Survey.

15. To obtain the required standard number of one fixed point and elevation within every 10 square miles of area, is undoubtedly difficult in forest-covered hilly ground, and it can only be secured under certain circumstances at a somewhat enhanced mileage cost, but I consider it of the utmost importance to uphold and enforce rigidly, every measure on which depends the system of topographical surveying with the plane table, and the accurate delineation of the features of the ground, and it affords me much satisfaction to state that the most strenuous exertions are made by the several executives in charge of parties, to arrive at, and maintain a high order of professional accuracy, as their maps and data rendered amply testify.

Nature of test applied to the season's outturn of final survey.

16. A rigorous system of check is now applied in each survey by test-lines or traversing, run through every plane table, and several hundred linear miles of chain or perambulator measurements, where practicable, have been made in addition to examination in *situ* or from fixed commanding points by means of intersections. Every executive in charge of a party is required to report before leaving the field of survey, that all the plane tabling has been duly examined and tested on the ground, and without this no season's work is considered complete.

Professional results.

17. The results and value of the season's triangulation and the plane table stations or fixings per square mile on which the accuracy of the delineation of the ground depends, are given in the following tabular statement:—

Surveys.	Number of Triangles.				Triangular Error in Seconds.		Mean Difference in Common Sides in Inches per Mile.				Average plane table fixings on each square mile of survey.	Remarks.
	1st Class.	2nd Class.	3rd Class.	4th Class.	1st Class.	2nd Class.	1st Class.	2nd Class.	3rd Class.	4th Class.		
								Inches.				
No. 1 ...	...	...	155	46	728	...	5·0″	...	2·92	2·49	6·46	10·5	
„ 2 ...	3	242	211	1,132	3·0″	12·9	...	6·20	11·00	20·30	..*	* No topography for the season, party re-organised.
„ 3 ...	...	250	...	...	...	17·1	...	6·00	...	...	4·7	
„ 4 ...	...	31	60	388	...	4·3	...	1·74	25·00	25·20	7·6	145 linear miles of check traversing.
„ 5 ...	...	...	...	...	...	...	...	...	...	...	6·0	
„ 6 ...	...	...	27	63	...	8·8	...	...	11·75	48·00†	..‡	† Distant peaks without marks.
„ 7 ...	...	57	...	398	...	2·7	...	1·75	...	8·88	8·5	‡ Military reconnoissance on scale 4 inches 1 mile

18. These results are most satisfactory, and prove that every possible care has been taken to uphold the general value and accuracy of the operations on which the topographical work depends. The lowest average number of plane table fixings appears in No. 3 survey, but the ground is a mass of forest-covered hills, and beyond doubt the most difficult to deal with allotted to any survey.

Remarks on the season's fair maps.

19. The actual area represented on the standard 1 inch scale sheets or sections of 15 minutes of latitude by 30 minutes of longitude, is about 17,398 square miles, contained in 41 sheets of double elephant size paper. All these have been carefully examined and the greater number have been already reproduced to scale and printed by the photozincographic process, and are under issue to various Government departments and officials. The whole series of the past season's work very recently received in this office, will be thus published before this report can be printed.

20. The area surveyed and mapped as above described, being all closely based on the Great Triangulation, furnishes valuable geographical materials for the Indian Atlas Sheets, which it is so important to fill up as follows:—

Nos. 1-5 & 7 Surveys.—In Sindiah's and Holkar's territory, Bhopal, Jodhpur, Udepur, Kota, Tonk and some of the smaller or petty states interlaced. Ajmere and Mhairwara; all within the Indore and Rajputana Political Agencies. } For portions of Atlas Sheets 34, 51, 52 and 53.

No. 3 Survey.—In the dependency of Bastar (Central Provinces) and in Jeypur, Vizianagram, Madgul and Panchpenta in the Vizagapatam Agency of the Madras Presidency. } For portions of Atlas Sheet 93.

No. 4 SURVEY.—In the zemindarees situated within the northern portion of District Belaspur, Central Provinces, and in Taluka Sohagpur of the Rewah State. } For portion of Atlas Sheet 90.

No. 6 SURVEY.—In the South Cachar Hills, Munipur State and Lushai Hills on the Eastern Frontier of Bengal. } For portions of Atlas Sheets 131 and 132.

21. Fully two-thirds of these geographical materials have been reduced to the $\frac{1}{4}$ inch or 4 miles=1 inch scale, and fair drawn on Atlas Sheets in outline for engraving, and a considerable portion is already on copper in various stages; a result which, for a second time, it affords me the greatest gratification to report for the information of Government, for nothing can more clearly illustrate one of the great advantages secured by the transfer of the engraving of the Indian Atlas Sheets to India, and the means it affords us of pushing on with the final publication of the several surveys as annually produced.

22. In fact the due and proper prosecution in this country, under competent management of the engraving which has for so many years languished in England without the necessary agency or superintendence for its systematic and continuous conduct, will, I believe, do more for the utilisation of the survey results, and for the economical working of the Department, by saving many of the numerous preliminary lithographed issues, which we have always been obliged to make, than any other measure. The details connected with the engraving branch which follow, will explain this more fully.

Relative value of Fair Maps.

23. There is a marked improvement generally in the style and execution of the 1 inch standard maps of the season, most of them are exceedingly well drawn, and highly creditable productions, the most meritorious draftsmen being distinguished by name. Relatively the following opinion has been formed.

No. 1 *Gwalior and Central India Survey.*—All the sheets are well finished, and the ground is effectively delineated. A few of the sheets failed to reproduce clearly by photozinco-carbon transfer, owing to the extreme fineness of the lines (pen work) used in expressing subordinate features and undulating ground. The best sheets are by Messrs. Bolst and Cornelius.

No. 3 *Survey, Central Provinces and Vizagapatam Agency.*—The extremely complicated difficult nature of the ground is well expressed. The writing of names and general finish defective. Most of the maps have reproduced fairly. Those by Mr. May are fair specimens of hill delineation.

No. 4 *Survey, North-Eastern Division, Central Provinces.*—The sheets are well finished, shewing much improvement, and the drawing generally is clear and bold, although somewhat stiff and conventional in style. With the exception of one sheet in which ravines, undulations and the lower slopes of the hills were expressed in very fine lines, and in pale ink, all have reproduced well. Mr. J. H. Wilson's drawing is clear and effective.

No. 5 *Survey, Bhopal and Malwa.*—Very clear, effective and bold drawing; some of the hill ranges appear to be rather heavily expressed, considering their low elevation above the general level of the country. All the sheets have reproduced clearly and well, especially those by Captains Riddell and Wilmer, which are very good specimens.

No. 6 *Survey, Lushai and South Cachar Hills.*—(Scale 4 miles=1 inch) ground well and clearly expressed by Mr. Robert for the small scale. The sheets have reproduced very clearly.

No. 7 *Survey Rajputana.*—Delineation of ground good and effective, all the sheets are carefully executed and have reproduced well. Those by Messrs. Todd and McNair are the best. The sheets of the larger scale (24 inches=1 mile) Simla survey, are very clearly and beautifully drawn by Captain George Strahan, and have reproduced well. Others by Mr. Stotesbury are also good specimens. These sheets are under reproduction as well as reduction on two-thirds the scale (16 inches=1 mile) of the original drawings.

Extracts from the Narrative reports of executives.

24. Valuable and interesting geographical, historical and traditionary notes, with remarks on the people, their manners and customs in various portions of the country brought under survey, extracted from the narrative professional reports of executives, are given in Appendix A..

25. During the season under review the combined area completed by topographical and revenue surveys, and the aggregate cost and mileage rate for final survey are given in the following table.

Combined results of Topographical and Revenue Surveys.

	Area completed, Square miles.	Total cost.	Average rate of survey per square mile.	Remarks.
		Rs.	Rs. A.	
UPPER CIRCLE, Punjab and North-West Provinces	8,057	4,27,547	53—1	This includes the cadastral or "field survey" in the North-West Provinces, area 597 square miles or 574,063 acres, on 16 inches=1 mile.
LOWER CIRCLE, Bengal, Central Provinces and Bombay	10,087	4,64,596	46—1	
REVENUE SURVEY Total ...	18,144	8,92,143	49—3	4,873 villages. 1,169 blocks and grants, &c., 18 river circuits.
TOPOGRAPHICAL SURVEY Total ..	17,910	3,71,616	20—10	
GRAND TOTAL ..	36,054	12,63,759	35—1	General average rate for topographical and revenue surveys combined, equal in English money to £3-10-1½d.

26. In the Revenue Survey, Upper Circle, (North-West Provinces) is included the cadastral or "field" survey on 16 inches =1 mile: 801 villages giving an area of 574,063 acres were surveyed on this system at a cost of 5 annas or 7½ pence per acre. Excluding the cadastral or "field" survey operations which are special, and in no way comparable with the ordinary village revenue survey on 4 inches =1 mile, the results of the revenue surveys are as shown in the margin.

	Area completed, square miles.	Total cost.	Average rate per square mile.
		Rs.	Rs. A.
Upper Circle	7,160	2,44,161	34 2
Lower „	10,987	4,64,596	46 1
TOTAL ...	17,247	7,08,757	41 2

27. The operations of the Revenue Survey Branch are separately reported on in full detail for the information of Government, by the Superintendents respectively in charge of the Upper and Lower circles. The general results are given here in combination with those of the topographical operations, to place before Government a brief but complete resumé of all the work under my general control.

Colonel J. E. Gastrell, Upper.
„ D. C. Vanrenen, Lower.

28. The total area accomplished by the sixteen parties of the Revenue Surveys (18,144 square miles) is in excess of the out-turn of the previous season, and the average rate of survey per square mile, Rs. 49-3, inclusive of the cost of the 16-inch "field" measurements, is moderate. The average rate for the 4-inch survey only, is Rs. 41-2 per square mile, or Rs. 4 less than the rate of the previous season.

29. The comparison of survey results, such as yearly progress, cost and mileage rates, one season with another, in a country such as India, and with the operations scattered widely apart and conducted under ever-varying conditions in different provinces, native states and districts, merely shews how far one season has been more successful than another. To arrive at any safe or reliable conclusions as regards the absolute comparative value of the work performed, careful consideration of many professional details and of the precise circumstances favoring or retarding progress and the physical aspect of the province or district is necessary. Such details are not given here, but are briefly referred to in the detailed reports on each executive survey party.

Opinion on the comparison of survey results.

30. The combined area accomplished by both topographical and Revenue surveys, *viz.*, 36,054 square miles, is 4,524 square miles in excess of that obtained last year, while the total cost and general average rate of survey are necessarily increased, *first*, in the Topographical Branch by the addition of No. 2 party which has only performed triangulation, thus shewing no completed area for the expenditure incurred, and *second* in the Revenue Branch by the Cadastral operations or "field" survey. With the further expansion of the larger scale Revenue Cadastral Surveys, a proportionate increase in the mileage rate must certainly follow.

31. The area accomplished up to 1871 by the revenue and topographical surveys of later date, almost entirely within the period of my own superintendence, but not including the work in other Presidencies, distinct from my control, nor the operations completed, or in progress, by the

Aggregate results brought up to date.

parties under the Great Trigonometrical Survey, were given in paragraph 23 of the last printed report, and the following statement completes the information up to 1872 :—

	Area completed in square miles.	Total cost.	General average rate of survey per square mile.
		Rs.	Rs.
Total of Topographical and Revenue Surveys up to 1871 ...	6,65,909	1,73,15,730	26 0 0
Ditto ditto ditto for 1872 ...	36,054	12,63,759	35 1 0
GRAND TOTAL UP TO END OF 1872 ...	7,01,963	1,85,79,549	26 7 0

32. It is from this enormous area of completed survey that geographical materials have been reduced, compiled, and furnished for no less than 46½ of the full sized plates of the Indian Atlas, each containing an area of 15,100 square miles. The progress and present state of the Atlas was more particularly described in the last report,* and the additions actually since made to the engraving, will be found under that head.

* Paras. 29 to 33.

33. The experiment of the combined revenue survey and settlement measurements ordered by the Government of India, to be carried out in the Bombay Presidency with the single party referred to in paragraphs 35 and 36 of the last report, employed in the Nassik district, having been fully tried and reported on after the result of an entire season's work, it was determined by the Government of India not to have been sufficiently successful to warrant its continuance on the same principles for another season, and with a second revenue party now deputed to the Ahmednuggur Collectorate.

Revenue Survey Parties in the Bombay Presidency.

34. The views of Government on this highly important question and my own opinions have been given at considerable length, whilst this report is passing through the press, in the letters marginally quoted.

A. R. C. No. 777, dated 13th December 1872.
S. G. No. 801F, dated 12th October 1872.
Do. No. 311, dated 3rd February 1873.

35. This question which involves many serious considerations in a professional point of view, being still under discussion by the Government of India, I have not deemed it necessary to go into further details in this place, than to record that the instructions received from the Government both as to the principles of conducting the surveys, and the change or transfer of districts as per margin, in which they are now ordered to take place, are being vigorously carried out.

Utilization of Bombay Revenue Survey measurements for geographical maps.

Sholapur, Poona.

36. The new cadastral surveys on the scale of 16 inches to the mile on strictly professional principles, are being extensively carried out in the districts of the North-Western Provinces as referred to in the last report.* The districts in hand are cited in the margin. I anticipate the very best results from these operations both financially and professionally as regards systematic and accurate measurement, with permanent recording of the maps of "fields" and ascertainment of true areas.

Cadastral Surveys.

* Paras. 37 to 39.

Moradabad, Muttra. Hummeerpur, Agra.

37. Eventually I believe they will prove not only invaluable as a correct permanent record of the landed tenures for all purposes of revenue assessment, water-rates, &c., but an immense saving of expense will be effected in the end, by doing away with the constant necessity for partial remeasurements for irrigation canals, railways, roads and other purposes, which are now perpetually being made in an irregular, unsatisfactory and expensive manner for emergent engineering objects. The results of the working of this new system of revenue survey on such large scales, are given in detail in the reports of the Revenue Branch of the Department. Head-quarter offices.

38. Having been called on to submit for the information of the Indian Finance Committee of the House of Commons, a succinct report as to the surveys carried on under the Government of India, the work performed and the cost of the same, a brief statement of all the surveys completed, in progress, and remaining, as well as of the mapping and publishing branches at head quarters, based on the cost for the season 1870-71, with which the sanctioned budget estimates could be compared, was rendered; and as it contains subjects of general interest, it is reprinted in the appendix,* but without its enclosures, which are not essential to its general scope or to a proper understanding of its contents.

Dated 27th December 1872.

* Vide Appendix B.

39. The important duty of preparing the survey results for publication devolves on the Drawing and Geographical Compiling Branch of my head quarters office, under the immediate and able superintendence of Mr. J. O. N. James, Assistant Surveyor General. Three publishing branches* have to be fed or supplied with work from this office, and all requisitions for the preparation of special maps, tracings, or copies of unpublished records and professional data, are also complied with by it.

Cartography.

* 1. Engraving.
2. Lithographic.
3. Photozincographic.

40. During the past year the usual compilation and reduction of geographical materials on various scales, and preparation of manuscript drawings, examination and correction of proofs, &c., has been carried on with increased activity and with great success. The usual details of the work performed are given in Appendix C, but the most important compilations and maps completed and in progress in various stages may be here briefly referred to.

41. Nine new quarter sheets of the Indian Atlas have been compiled and drawn (outlines and names) and delivered to the engravers, and hill drawing completed for five quarter sheets. Quarter Sheets 34 south-east, 34 north-east, 52 north-east and 52 south-east are under compilation. Of the proofs of Atlas Sheets received from the India Office, the engraving of which is to be completed in England, all blanks have been filled up in manuscript drawing on five quarter, and two full* plates, and the proofs have lately been returned to England. The drawings on the proofs of two more quarter plates, and three full plates (70 north-east, 71 north-west, 104, 54, 118) are in progress and will be returned to the India Office as soon as completed; 78 proofs (1st, 2nd, and 3rd) of plates in the engraver's hands have been examined and corrected.

Atlas Sheets.

* 50 and 89 (full plates) very heavy additions. Quarter plates 51 north-west, 70 north-west, 20 south-west, 105 north-west, 105 south-east.

42. The standard map of India, scale 32 miles=1 inch, has been further advanced and completed as far as survey results were available, to enable a photographed reduction to half scale to be made from it. One sheet of the latter map on 64 miles=1 inch is now engraving in outline, and the remaining three will be taken up as means admit, during the current year. It is a very great object to push on with this admirable sized map, which has long been under preparation, as it will supply a very great want long felt. With the skeleton once on copper, many advantages and great facilities will be obtained for bringing out new editions.

General Maps.

43. A new standard map of Bengal (in outline), scale 16 miles=1 inch, as a sister map to that of the Punjab and the North-Western Provinces, has been completed and photozincographed, but the boundaries of districts and divisions, pending their final adjustment have not been inserted. It has been printed in outline only, with the object of obtaining the latest information regarding territorial changes, canals, roads, &c., and, when completed, will be engraved.

44. A new general map of the Eastern Frontier of Bengal, on the scale of 4 miles=1 inch, has been commenced, and fair progress has been made on two sheets; it awaits further explorations now in course of execution, and after the present season's surveys the whole of the Eastern Frontier and Lushai territory it is hoped, will be fairly represented.

45. The Eastern Punjab Section of Sir Henry James' projection of a map of the World (scale 10 miles=1 inch) has been well advanced.

46. The introduction of photozincography, by which all the current standard sheets of the topographical surveys are now published, has left a great desideratum with regard to the maps of old surveys of former days, which being highly colored, and rendered in various styles and forms, are not susceptible of rapid treatment by the above process and have never seen the light. It is therefore an object to provide for this heavy task at head-quarters, and no less than 24 sections of the 1 inch standard maps, each 15 minutes of latitude by 30 minutes of longitude, of the earlier portions of the Rewah and Bundelkund, Chota Nagpur Division and Ganjam and Orissa Topographical Surveys, have been recompiled and redrawn in pen and ink and published: 20 more are in progress and the whole series must be similarly dealt with which will be a work of great labor and time, but the necessity of publishing all surveys is now admittedly so great, that I am anxious to secure the services of the best practical departmental draftsmen who have a knowledge of, and experience in, the difficult art of delineating ground, to go on with this work.

47. The services of Mr. J. O. N. James in the conduct of this branch of the Department, and as my Personal Assistant in all the various duties at head-quarters, call for a very strong expression of my approval and hearty acknowledgments.—Mr. James is a tried officer of 27 years departmental experience, and his knowledge is as varied and extensive, as his labors are indefatigable and cheerfully rendered. The value of this Deputy Superintendent's services cannot be too often or too strongly brought to the notice of superior authority.

48. Great progress has been made in the Engraving Branch during the past year with the plates of the Indian Atlas. Five quarter plates as per margin, have been completed and published as far as survey results were available, making in all 18 quarter plates engraved and published in India up to the end of the year 1872 and the quarter plates 9 south-east, 11 south-west, 33 north-east, 34 north-east, and 86 south-west have been finished but not published within the year; they are now being printed. 124 north-west and 125 north-east have been completed, but need trifling additions and corrections; 2 south-west and 53 south-east have been completed in outline and names. The old full plate, No. 68 containing a large portion of Oudh, has also been completed with the new surveys and the final corrections are in progress.

Engraving.

10 north-west.
11 north-west, north east.
32 south-east, 32 north-east.
Plates not quite full.

49. In addition to the above, 18 quarter plates are in various stages of progress, from outline and writing to hill etching and finishing, and heavy additions are being made to the old full plates of sheets Nos. 73 and 88 from the results of late surveys.

50. Corrections and additions of all the recent improvements in the Town, to the plates of Simm's plan of Calcutta, are also being pushed on to complete it up to date with a view to a new edition being brought out as early as possible. A very useful skeleton map of the Punjab and surrounding country scale 32 miles = 1 inch, to illustrate administration reports has been completed and published, and the outlines of the map of Oudh, scale 16 miles=1 inch, are nearly finished.

51. Details of all the work completed and in progress in the Engraving Branch are given in Appendix D. The European staff was for a considerable portion of the year greatly reduced in strength by sickness, which told much on the work, and I have with much regret to record the death of Mr M. H. West on the 5th April last, whose place was not filled up for many months afterwards.

Increase of Engraving Staff.

Surveyor General's letters No. 514, dated 12th March 1872, No. 670, dated 9th April 1872.
Financial Department Resolution No. 3139, dated 30th April 1872.
Secretary of State's Despatch No. 19, dated 18th July 1872

52. A considerable increase has been made to both the European and Native establishment of engravers in accordance with the correspondence* marginally noted, sixteen Native apprentices were entertained from the 2nd September 1872, and are all under instruction and training in the first steps of the art of engraving on copper. One European Engraver (Mr. T. B. Rodger), was with the sanction of the Government of India* entertained in Calcutta on probation from the 20th August 1872, and three new engravers appointed by the Right Hon'ble the Secretary of State, besides one sent out in the place of Mr. West, deceased, joined on the dates specified opposite their names in the margin. Twelve European etchers and engravers were recommended and duly approved and sanctioned by the Government of India, but the number was reduced to three by the Home authorities.

* Financial Department order No. 1832, dated 8th August 1872.
† Mr. G. G. Palmer, 5th November 1872, Etcher.
Mr. O. Tarrant; 5th November 1872, Engraver.
Mr. D. Mitchell, 3rd December 1872, Etcher.
„ J. Fulford, 16th December 1872, Engraver.

53. A plate printer* (Mr. Martin,) is shortly expected to replace Mr. Haughton dismissed in September last.

* Appointed by the Secretary of State, vide despatch No. 36, dated India Office, 18th December 1872.

54. The old Native Staff of engravers and apprentices (11 in number) entertained in 1869, have made excellent progress, and are all now employed fully on the plates of the subordinate portions of the Indian Atlas, but they of course still need a considerable amount of aid and European supervision. Their progress in hill etching is very fair and commendable, but this is a most difficult art and needs years of careful study and practice even for Europeans, of whom there are very few proficients indeed, even in England. Yet under Mr. Coard's able tuition and guidance, four of the men give fair hopes of becoming skilful etchers in time, and some very creditable specimens of hill work have been already produced.

Remarks on the progress made by the Native engravers.

55. It will be seen from the statement (Appendix D) that less copper plate printing has been executed this year than in 1871, as with the primary object of saving the wear and tear of the plates, very few copies are pulled from the copper; transfers to stone from the engravings have been taken, and the full number of impressions required were printed from stone, and answer every purpose.

Copper plate printing.

56. The process of steel facing the copper plates to harden them before printing, has been discussed and ordered by the Home authorities to be carried out. The necessary apparatus

has been sent out from England for the purpose, but arrived in a very damaged state. It is now being renewed here, and will shortly be put in operation.

57. Consequent on the dismissal of Mr. Hanghton, plate printer, and his departure for England in September last, as well as the death of the head Native printer, considerable inconvenience has been felt and additional labor has been imposed on the Superintendent of the Engraving Branch, in looking after the details of the plate printing, which require careful and experienced supervision. It affords me great satisfaction to state that Mr. Coard continues well and ably to perform every duty connected with his department, and renders me the highest satisfaction. The European staff have likewise worked well.

58. With reference to the arrangements sanctioning the transfer to India of the engraving of the copper plates of the Indian Atlas under my immediate supervision, the plates as per margin have been received lately from the India Office, and advise of the despatch of the plates marginally* noted has been likewise received, while this report was passing through the press. The possession of the plates in this office, places us in a very advantageous position with respect to the power of revising the sheets by the new surveys received, and enables us to bring out fresh editions from time to time as emergencies arise.

Transfer of the copper plates of the Indian atlas from England to India.

1 N. E., 1 S. E., 8 S. W., 27 (A) N. E., 27 S. E., and 14, 15, 16 and 29 old full size plates, 44 (A) N. W. and S. W., 45 S. W. and N. W., 51 N. E., 69 N. E., N. W. and S. W., 70 S. E., and 65, 66, 67 and 102 old full size plates.

* 106, 107, 108, 111, 115 and 116.

59. With the additional European agency now allowed, it is expected that most of the quarter plates reported as in progress will be completed during the year, and that some of the plates of the standard maps of India and Bengal (in outline) will be taken in hand. The new native engravers and apprentices, entertained only in September last, are not likely to be able to take a share in any Atlas Plates for at least another year, but the state of the native agency is most encouraging, and its instruction most carefully provided for.

60. Owing to the temporary deputation of Captain W. G. Murray, Assistant Surveyor General, to the Archæological Survey from the month of April last, and to the serious illness of that officer after his return to Calcutta from Kashmir in October last, the duties connected with the superintendence of the Lithographic Branch of this office, have been conducted by Captain J. Waterhouse, Assistant Surveyor General, for nearly the whole of the past year in addition to the work which usually devolves on him of the Photographic Department.

Lithographic Branch.

61. The heavy demands on this branch for all descriptions of lithographic drawing and printing of Survey and special maps, plans and illustrations for reports, from various departments, continues as usual. In addition to an immense amount of miscellaneous work the following new and important maps from the results of the operations of this department, have been published in excellent style since last report.

Province of Sindh, sheets 1, 2 and 4	Scale 4 miles = 1 inch.
Eastern Bengal sheet 7, 8, 9 and 10	Scale 8 miles = 1 inch.
Burdwan Division	8 miles = 1 inch.
Bhaugulpur Division	8 miles = 1 inch.
Province Sindh (standard Revenue Survey sheets) Nos. 43, 45, 46, 47, 48, 57, 58, 59, 60, 61, 70, 77, 80, 81, 84, 88, 89, 91	1 mile = 1 inch.
Province Oudh (standard Revenue Survey sheets) Nos. 25 and 26 — — — — —	1 mile = 1 inch.
District Lohardugga, Standard Revenue Sheets, 7 8, and 9—	1 mile = 1 inch.
„ Bijnour „ „ „ 5 and 6 —	1 mile 1 = 1 inch.
„ Chanda „ „ „ 2, 3 (a), 3 (c), 7 (a), 15 and 17 — — — —	1 mile = 1 inch.
Kooch Behar State „ „ „ 1, 2, 3 and 4	1 mile = 1 inch.

62. Complete details of the nature and value of the work performed are given in Appendix E. The improvements in color printing or chromo-lithography have made rapid strides of late, and the sheets of the geological survey may bear comparison with any thing of the same sort executed in England, which reflects great credit on the head printer Mr. Niven and on the Superintendent Mr. Jevezy. The general results are as follows :—

	Subjects or sheets.	Number of copies printed.	Value or selling price.	Remarks.
Province, District and General Maps, Index Maps and Plans	387	28,265	39,360	
Miscellaneous Maps, Plans, Sketches, Tints, Diagrams, &c.	315	1,49,721*	31,308	* Nearly all these were printed for various Government Departments, totally unconnected with this Office.
Total ..	702	1,77,986	70,668	

In addition to the above, 156,135 copies of professional forms, departmental orders and circulars have been printed.

63. Captain W. G. Murray, Assistant Surveyor General, rejoined from his special deputation on the Archæological tour to assist Major General Cunningham on the 21st of October 1872, but owing to his health having completely broken down, he has, I much regret to state been compelled to apply for furlough to Europe* for two years under medical advice. The loss of this experienced officer's services will be much felt, and they will be difficult to replace at the present moment. I have had frequent occasion to record my appreciation of this officer's professional ability, and the hearty and effective aid he has always rendered during the time he has been attached to this office since March 1869. Captain Murray's report of his Archæological pursuits in the Himalayas, now under submission, will, I doubt not, add materially to his reputation as an admirable photographer and keen observer. He took the silver medal prize at the Calcutta photographic exhibition of the present year for a very excellent series of views in Cashmere and Northern India.

* Since obtained furlough to Europe by G. O. No. 113, dated the 5th February 1873.

64. This branch of my head-quarter's office under the able and very energetic superintendence of Captain J. Waterhouse, Assistant Surveyor General, has worked most satisfactorily during the past year. Both the quality and quantity of the out-turn is much improved, and no efforts have been spared to meet the urgent demands for the immediate reproduction and issue of the regular survey and special maps and other subjects for all branches of the public service. At the recent exhibition of the Bengal photographic society, the silver medal for the best series of Indian subjects was awarded to this office for a collection of fine photographs of Indian jewelry, musical instruments, &c., originally prepared for the London International Exhibition of 1872.

Photographic Branch.

65. A detailed report on the working of this branch is given in Appendix F. The general results obtained are as follows :—

	Number of subjects.	Silver prints.	Number of complete copies printed.	Remarks.
Topographical and Revenue Survey Maps and Charts	849	139	36,769	Of the Revenue Survey Maps 3,700 copies were printed from Anastatic transfers.
District and general maps City and Cantonment plans	100	133	16,947	Of District Maps 1,230 copies were printed from Anastatic transfer.
Miscellaneous maps, plans, and diagrams. Proofs zincographic and Anastatic transfers	479	3,928	63,604	Of miscellaneous maps 85 copies were from Anastatic transfers, and 2216 copies from Zincographs.
Total ...	1,428	4,200	1,17,320	

66. Captain Waterhouse has been indefatigable in his endeavours to work out and apply to cartography all the latest improvements and especially the new "photocollotype" process, which promises to become of great importance and advantage, and has fairly succeeded in his efforts as will be seen from the beautiful specimen map of a reduced Atlas Sheet attached to Appendix F. He has had many difficulties to overcome in ascertaining the conditions of successful working in a tropical climate, as well as of obtaining or manufacturing the necessary inks and appliances essential to secure success, but with his usual energy and perseverance, he has by a continued series of experiments and careful study of each step of the process, worked out every detail, and has produced several very beautiful ink prints from the "insoluble gelatine films," on which the original subjects were copied by the photographic process.

New Photocollotype Process.

67. In the description of the process given in Appendix F, Captain Waterhouse has fully detailed the advantages likely to be gained by the adoption of the process in this office for the reproduction of all kinds of subjects, both in line and half tone, and thus replacing in many cases the slow and costly methods of lithography and silver printing for such subjects as are not susceptible of being reproduced by photozincography. By its means the finest and most delicate subjects in *line*, such as manuscript maps or pen and ink drawings, engravings, &c., may be copied with inimitable accuracy, clearness, and sharpness, and will thus yield a *far* more perfect transcript of the original than the comparatively coarse process of photozincography. The most important advantage of this process, however, is the facility it affords for making copies of colored or tinted drawings and also of ordinary photographs from nature. Such subjects cannot be reproduced successfully by photozincography, and therefore must either be lithographed or photographed in the ordinary manner, both of which methods involve a loss of time, and an expense which in many cases is quite prohibitory, but this application of the process will enable the Photographic Office to supply any demands for photographs to illustrate reports or any other purpose, with the utmost rapidity and at the smallest possible cost. The process also offers extraordinary facilities for color printing, but the development of this application must be postponed until perfect success is attained in the general working.

68. A very excellent collection of engravings, photographs, photozincographs, lithographs and chromos, has been made under Captain Waterhouse's superintendence for transmission to the Vienna Exhibition, which, it is hoped, will uphold the credit and reputation of the department.

69. Captain Waterhouse's services are most valuable to this Department in every way, and I desire to bring the same prominently to the notice of the Government of India as meriting every commendation and suitable improvement in his grading or Departmental position, for which he will be specially recommended. It would be impossible to find a more able and zealous coadjutor, or an officer more deserving.

70. Regular quarterly despatches of all maps, plans, and charts published by this Department have been made to the India Office, London, to the extent specified in the margin. These maps comprise the results of all the imperial surveys of India in the Topographical, Revenue and Trigonometrical Branches on every scale onwhich they are published. Of all the large scale plans and maps, from 10 to 30 copies are usually sent to the India Office, while of general maps, on various geographical scales, a larger number are forwarded in the belief that maps suited to purposes of general reference will be more useful and better appreciated in England than the special ones on large scales.

Despatch of maps to the India Office.

9th January 1872,	1,650	complete maps, charts, &c.
4th April ,,	2,340	do. do.
1st July ,,	1,160	do. do.
4th October ,,	2,200	do. do.
TOTAL	7,450	maps, plans, charts, &c.

71. As the cost and labor of coloring, more especially the large scale maps and plans, is very great, it is very desirable that some expression of opinion should be obtained from the India Office as to whether any demand exists for these publications on large scales in England, and whether they are easily provided with convenient space at the Geographical Department of the India Office, and are accessible to the public, otherwise it may be advisable to reduce the number of copies of each description at present despatched. This point will be ascertained for future guidance.

72. During the year (1872) the issue of maps to Government officials and sales to the public through the several agents, as detailed in the following statement, show an increased demand for the publications of the Survey Department :—

Sale and issue of maps in India.

	Number of maps.	Value or selling price.	
		Rs.	
To Government officials issued on service	25,890	43,421	In 1871 the total number of maps issued and sold was 29,970, and the money value was Rs. 52,536, exclusive of those sent to the Superintendents of Revenue Survey Office.
To Geographical Department, India Office, London ...	7,450	11,460	
To Agents for sale to the public and issue to Government officials	4,017	7,837	
TOTAL ...	37,357*	62,718	* This does not include the special maps printed for Local Governments and various Departments issued from the Lithographic and Photozincographic Branches.

73. The correspondence and business connected with this growing duty of supplying maps gratis on the public service is very severe, entailing an amount of work and an expense for mounting, binding, coloring, and postage which this office is no longer equal to cope with, or to provide the funds from the Departmental Budget for gratuitous issue to such an extent. The cost of binding and mounting maps supplied *ad libitum* to every Government official, who newly takes charge of an appointment, has now risen to a very considerable sum monthly, and it becomes a question whether, under the existing financial system of every department paying for its own wants, this office ought to bear such heavy collateral expenses in addition to giving away its own maps. The whole system of the issue of maps gratis requires consideration, and proposals will be made for relieving this office of the entire duty and transferring it to the agents.

74. The cash account connected with map sales up to the 31st December 1872 is given with appendix C. The total sum paid into the Treasury during the year amounts to Rs. 11,324-3-7, and a further sum of about Rs. 4,000 is still due by map sales agents in different parts of the country, which, as soon as realised, will also be deposited in the Treasury. In accordance with the instructions of the Comptroller General of Accounts, no cash balances of any kind are now kept at credit of this office in the Bank of Bengal; and for all sums of money paid into the Treasury on Government account, the receipts are at once forwarded to the Comptroller General, and the transactionsare thus closed.

75. The above forms a brief butimperfect general review of the various transactions in the administrative offices, and I proceed now to describe in detail, what has been performed by the Executive Establishments in the Field.

EXECUTIVE ESTABLISHMENTS.

No. 1.—TOPOGRAPHICAL SURVEY.

GWALIOR AND CENTRAL INDIA.

76. Captain Charles Strahan, R. E. Deputy Superintendent, in charge of No. 1 Survey having obtained furlough to Europe by G. O. G. G. No. 983, dated the 4th November 1871, delivered over charge of the party, of the strength as per margin, to Lieutenant Holdich, R. E., Assistant Superintendent, on the 3rd of November 1871, who conducted it from Mussoorie into the field. The operations of the season (1871-72) lay in the blocks of Degrees Nos. 8 and 9 within portions of the Native States marginally named; the triangulation in advance was carried over the Square Degree No. 10, chiefly consisting of Jhalra Patan and Tonk, Rajputana Agency States, defined by the meridians 76° to 77°, Latitude 24° to 25°, and the topographical detail over the country within Longitude 77° and 77° 30′, Latitude 24° and 25°, with a small detached area east from Longitude 78° and extending to the Betwa River, or up to the Longitude 78° 15′ nearly.

Portions of Gwalior (Sindiah's territory), with interspersed portions of Holkar, Kotah, Tonk, Jhalwar, and Kurwai Native States.

STRENGTH OF PARTY.	Field work executed in square miles.	
	Topography.	Triangulation.
Captain Charles Strahan, R. E., Deputy Superintendent, 3rd grade, on furlough to Europe, from the 3rd December 1871.		
Lieutenant T. H. Holdich, R. E., Assistant Superintendent, 1st grade, officiating in charge ...	61	2,080
Mr. J. H. Bolst, Surveyor, 2nd grade ...	63	2,160
„ R. D. Farrell, ditto 4th „ ...	271	
„ C. A. Scanlan, Asst. Surveyor, 1st „ ...	300	
„ G. K. Allnutt, ditto 3rd „ ...	337	
„ S. D. Ryan, ditto 3rd „ ...	270	
„ W. J. Cornelius, ditto 4th „ ...	395	
„ C. T. Templeton, ditto 4th „ ...	218	
SUB-SURVEYORS.		
Josla Pershad	304	
Abdul Samad Khan	264	
Abdul Sobhan	60	
Churamun Lall	150	
Abdul Guffur	97	
Total Square Miles ...	2,780	

77. The total out-turn for the season, as made up by the several assistants, is exceedingly good, amounting to 2,780 square miles of final topography, with triangulation in advance of details of 4,200 square miles.

Remarks on the country finally surveyed.

78. The eastern portion of the area brought under final surveys embraced the left bank of the Betwa River in the Mangouli Soubahdaree to the extreme limits of the assigned division for surveys on the parallel of 24° near Sironj, and is described by Lieutenant Holdich (*vide* extracts in Appendix) as an intricate forest-covered country: the remainder, or main block of topography accomplished, was along the Agra and Indore Road around Goonah in the District or Soubah of Bajrangarh through difficult ground; on the north, or towards the head of the Kunn Valley, the ground is covered by a mass of precipitous scarped hills overgrown with heavy scrub jungle, while to the south and westward the country slopes away to the Parbati River, and is overgrown with grass and heavy forest, in which water is scarce, and the population reduced to a minimum by constantly recurring famines. Both the square degrees above specified have thus been well completed up to margins.

79. Thus, from the commencement of the Gwalior Survey in 1860-61, no less than eight square degrees of country have been completed, extending from the parallel of 28° to the parallel of 24°, and confined by the British districts of the North-West Provinces on the east and the meridian of 76° on the west, comprising about 32,000 square miles. The chief portion of Sindiah's territory has been accomplished, and the 4 inch maps published. For this purpose all the old sheets of the earlier seasons' survey rendered in color and brush shading, had to be redrawn at head-quarters for reproduction by the photozinco process, and I am happy to say the whole of these arrears have been cleared off and the entire series of maps issued in a uniform style. There are still some interlaced and detached portions of the Soubahs, as per margin, remaining to be taken up, which will fall within the Bhopal Agency survey, whilst the Gwalior Party will now meet more with the Rajputana States lying within the limits before described.

Mundisore, Augur, Oogein, and Mangouli.

80. Interesting and valuable notes, descriptive of the country through which the season's operations extended, by Lieutenant Holdich and Messrs. Bolst and Scanlan, are given in the Appendix.

Professional results obtained.

81. By the season's triangulation 439 positions were fixed and 834 heights determined by observations at 78 stations; the average linear error for sides of secondary and minor triangles being 2·7 inches per mile, and for sides of intersected points 6·5 inches per mile. It is satisfactory to find that the average number of plane table fixings for the detail topography was 10·5 per square mile.

Cost of the season's operations.

82. The total cost of the season's operations, including all charges for establishments and contingencies, both for field and recess work, amounts to Rs. 54,527.

83. Great credit is due to Lieutenant Holdich for the very satisfactory manner in which he has conducted the duties entrusted to him, during this first year of his charge. The delineation of his topography appears to have been well maintained in the hilly, rugged, and forest clad, as well as in the open cultivated tracts; the work has been systematically squared up, and the whole of the records have been completed and rendered in a satisfactory and masterly manner. Lieutenant Holdich has served a long apprenticeship in the Department as an Assistant Superintendent, and being both highly qualified and energetic, is most deserving of a higher grade than the one in which he is still serving.

Opinion.

84. Lieutenant Holdich acknowledges his indebtedness to Major Martin the Political Agent at Goonah, for valuable advice and very effective aid rendered to the survey throughout the season. In the Kotah State little or no assistance was rendered by the native officials, and great difficulty was, in consequence, experienced in carrying the triangulation through it. In other States there has been great improvement this season as to the assistance rendered to the survey officers.

85. During the current season the topographical delineation of the country within the meridians of 76° 30′ and 77°, and parallels of 24° and 25°, or Degree No. X already triangulated, will be taken up, while the triangulation will be advanced westward from longitude 76° between the same parallels into Degree No. XI.

Future operations.

86. To provide a sufficient and convenient field for No. 5 Survey, Bhopal and Malwa, adjoining on the south (*vide* paragraph 99 of printed report for season 1870-71), and to relieve the Rajputana Survey (No. 7), immediately adjoining on the west, of some of the immense area originally allotted to it, it has been found necessary to extend the operations of No. 1 Survey westwards of its original meridian of 76° through Neemuch, Odeypur, and Sirohee, and to reduce it southwards. This party, therefore, will in consequence be confined in future between the parallels of 24° and 25°.

87. By this arrangement each of the three parties working in the Rajputana and Central India Agencies, will have a convenient sized field of operations before them without clashing, and sufficient to occupy such establishments for several years to come. A new index map has been published to show this distribution of area.

88. The following changes in the personnel of this establishment have taken place during the year. Lieutenant Leach, B. E., who was appointed to the Department in November 1871, having completed the special duty in which he was detached with the Lushai Military Expedition on the Eastern Frontier, joined the party in the month of June last, and took part in the recess duties. Mr. Allnutt, Assistant Surveyor, was permitted, at his own request, to resign his appointment from the 1st June 1872. Mr. Ryan and Sub-Surveyor Churamun Lall were transferred to help to raise the new No. 2 Khandesh and Bombay Native States Party. To fill these vacancies the Assistant Surveyors marginally named, were appointed to the Department, and posted to this party to complete the sanctioned scale of European Field Establishment. The party is now in a very efficient state.

Changes in the strength of party.

Mr. J. H. O'Brien, 1st November 1872.
„ W. M. Kelly, ditto ditto.

No. 2.—TOPOGRAPHICAL SURVEY.

Khandesh and Bombay Native States.

89. This party, which was originally employed in Hydrabad, the Berars, and Central Provinces and disbanded in 1870, was again revived under the orders of the Government of India, marginally cited, for the topographical survey of the hilly portion of the District of Khandesh in the Bombay Presidency, chiefly situated between the Taptee and Nerbudda Rivers, as well as of the Native States adjoining Khandesh on the north and north-west, as alluded to in paragraphs 34 and 77 of my printed last general report for season 1870-71.

District Khandesh, Bombay Presidency, portions of the Native States of Holkar, Sindiah, Burwani, and Dhar of the Rajputana Political Agency, and Allirajpur, Rajpipla, &c.

Strength of Party.

F. B. Girdlestone, Esq., Officiating Deputy Superintendent, 3rd grade, in charge.
Mr. N. A. Belletty, Surveyor, 1st grade.
„ P. J. Doran, Assistant Surveyor, 3rd grade.
„ W. C. G. Barckly, Ditto. 4th grade.

Sub-Surveyors.

Ganesh Wamon.
Keshow Wamon.

Department of Agriculture, Revenue and Commerce letter No. 193, dated 6th September 1871.

90. The chief object of the deputation of this party is, for a proper topographical survey of the native and other hilly states in the Bombay Presidency, which in the northern division have been left untouched for so many years past, and to supply geographical materials for those sheets of the Atlas of India, which the operations of the Revenue Settlement Department have been unable to render, and which for so many years have remained blank on the index map of the Indian Atlas.

91. The area at present allotted to this survey, extends from the Taptee River northwards to the southern face of the Vindhya range, or from about Latitude 21° 0′ to 22° 30′, and from the western boundary of the District of Nimaur in about Longitude 76° 10′ to about 74° 15′, or to the eastern limits of the Guzerat Survey under the Trigonometrical Branch of the Department. This tract comprises the continuation of the Sathpura range and other isolated hills south of the Taptee, as far as the limits of the western ghâts and is very little known indeed. The southern portion of Khandesh, consisting of the open cultivated and revenue-paying tracts, but of which no reliable maps exist, is open to future enquiry, as to the necessity or otherwise of further topographical operations, or as to the practicability of utilising the Bombay Settlement Officer's measurements, with a view to the production of tangible maps of reference for general engineering, revenue and other purposes.

92. Owing to the reductions effected in the strength of the Department during the year 1870, considerable difficulty was experienced in drafting even a small number of efficient assistants from other surveys to start the advance triangulation in Khandesh, and it was only towards the close of the year (December 1871), and at the cost of materially reducing the strength of other barely efficient surveys, and consequently their working power and cost per square mile, that this party was reformed as above described.

Difficulty experienced in recruiting the party.

93. During this first season, and for the purpose of breaking ground, it was not possible to effect more than the completion of a sufficient amount of skeleton triangulation on which to base the topography afterwards. With this object in view all the country from the meridian of the Khanpisura Series of the Great Trigonometrical Survey eastward, as far as the boundary of District Nimar already surveyed, or from the meridian of 75° to 76° 10′, was reconnoitred, and the triangulation of an area of about 4,940 square miles effected.

Season's operations and out-turn.

94. The initial elements for this triangulation were obtained from the Khanpisura Series stations, Argaon, Ajne, Babakor, Jelalabad, Tikree, Baumungur, and Mograba, situated between the Taptee and Nerbudda Rivers, and the net work was thrown to the north of the Nerbudda River to the full limits of the survey, where it will connect with the Bhopal and Malwa operations a little south of the city of Indore, nearly on the parallel of 22° 30′.

95. Observations were taken at 137 stations, from which 831 points, or on an average nearly 1 point or station was fixed in every 6 square miles of ground, and 589 heights were determined trigonometrically, giving on an average 1 height for every 8¼ square miles.

96. The ground over which the triangulation was conducted was in parts very hilly, forest-clad and unpopulated, especially in the southern portion, along which runs the main range of the Sathpura. It was found to be highly malarious up to the middle of February. Provisions and water were scarce, and had to be carried about for the survey camps, which, together with the very high price of labor and of every necessary of life, has entailed a severe expense, especially for the first starting and equipment of a new party. Several plateaux were discovered, which are described by the Officiating Deputy Superintendent as possessing a delightful climate even in the month of May, and entirely free from hot winds. The most important of these are noted in the margin.

Remarks on the country triangulated.

Kotah—Latitude 21° 30′ 5″ } Height 3,000 feet.
Longitude 75 51 30 }

Huri—Latitude 21° 32′ 37″ } Height 3,073 feet.
Longitude 75 51 6 }

Distant 32 miles from the Great Indian Peninsula Railway Station of Raveree.

97. The highest hill fixed by the season's operations is that of "Panchpandia:" height 3,522 feet, Latitude 21° 19′ 5″, Longitude 75° 40′ 34″; the next in importance is the sacred hill of "Tasdin" height 3,389 feet. The character of the country will, however, be better described next season, when the topography has been laid down and every nook and corner visited, as it must be, by the detail surveyors. A few notes will be found in the Appendix.

98. The establishment, which experienced an unusually heavy and difficult season's work, repaired to the rendezvous at Bhosawul by the beginning of June, from whence they proceeded to Mussoorie, where the recruiting of their health, as well as the completion of the organisation of a full party, could best be arranged in concert with the other executive officers at that place. The usual professional computations were completed.

Recess duties.

99. The total cost of the season's operations from the time the establishment was inaugurated (December 1871) to September 30th, amounts to Rs. 37,967.

Cost of the season's operations.

100. The triangulation completed in advance being sufficient to afford a basis for the detail survey for the next two seasons, the main portion of the party will be employed on the topographical delineation of the country within Latitude 22° 15′ to 21° 45, Longitude 75° to 76°. The executive officer and one assistant will take up a small portion of triangulation remaining to be completed east of Longitude 76°, and also fill up whatever minor additional points may be found necessary in any of the triangles of the past season.

Programme for the current season.

101. The party has now been raised to full strength by the several transfers and postings marginally noted. These withdrawals require the training of new agency, and to ensure a fair out-turn of topography on each party during the current season, new hands have been carefully selected and appointed to fill up the vacancies; but it is a tedious and expensive task to train Topographical Surveyors, and though every precaution is taken to secure only the best men, and only those who show considerable aptitude for the work, it seldom happens that a good topographer is fully trained or returns a full and sufficiently reliable amount of work for his pay in less than three or four years.

ADDITIONS TO THE STRENGTH OF THE PARTY.

Mr. R. W. Chew, Surveyor, 3rd grade, from No. 3 Survey.
„ A. G. Wyatt, Asst. Survr., 1st grade, from „ 4 do.
„ T. D. Ryan, do. 2nd grade, from „ 5 do.
„ G. T. Lambert, do. 4th grade appointed 1st July 1872.
Sub-Surveyor Shaik Omer from No. 4 Survey.
Do. Churaimun Lall from No. 1 Survey.

102. The skeleton out-turn of the season is good, considering that the party just raised was employed in entirely new and difficult ground and in a new presidency; much credit is due to the Officiating Deputy Superintendent, Mr. F. B. Girdlestone, for the energy displayed in the formation of the establishment, and success achieved in overcoming the many difficulties he had to contend against.

Opinion on the season's out-turn.

103. The party suffered considerably from fever throughout the season. An outbreak of cholera also took place, and one Assistant Mr. Doran, was totally incapacitated early in the season, and obliged to take nine months leave under medical certificate, and is unfitted for field duty during the whole of the present season.

104. I record these facts simply to shew what affects progress in this country, and the precariousness of such operations in many parts of India.

No. 3.—TOPOGRAPHICAL SURVEY.

CENTRAL PROVINCES AND VIZAGAPATAM AGENCY.

105. The topography in continuation of the previous season's operations was taken up in these wild States from the parallel of 18° 30′ and extended southwards to 18° 15′ with a small portion to the east lower south to 18°, and limited to the west and east by the meridians of 81° 30′ and 83° 10′, the tract of country immediately due west of Vizianngram. The triangulation of this party being very much in advance, there was no necessity to extend it further during this season; the Deputy Superintendent, Colonel Saxton, was therefore chiefly employed in inspecting the work of his detail parties, and rendering them such help as they needed from time to time, and his attention was also given to fixing by interpolation, within the triangulation of previous seasons, where required, additional points to facilitate the work of the plane tablers.

Portions of Bustar State in the eastern part of the Central Provinces, and of Jeypur, Madgul, Panchpenta and Vizianngram in the Vizagapatam Agency, Madras Presidency.

STRENGTH OF PARTY.			Out-turn of Topography.	
Col. G. H. Saxton, Depy. in charge ...	Supdt. 1st grade, ...	...	40	Square miles and interpolation of points.
Mr. R. W. Chew,	Surveyor, 3rd grade	...	341	Square miles.
„ J. Harper,	do., do. ...	...	246	do.
„ J. A. May,	do., 4th grade	...	240	do.
„ F. Adams,	do., do.	...	282	do.
„ T. E. M. Clandius,	Asst. Surveyor, 2nd grade.		329	do.
„ W. F. Pettigrew,	do., 3rd do.		243	do.
„ A. Cooper,	do., 3rd do.		282	do.
	Total ...		2,003	Square Miles.

106. The whole season's operations lay through hilly, inhospitable, unhealthy, and very sparsely inhabited country, and is described as some of the wildest and most difficult in this province. Some of the ranges of these eastern ghauts attain a height of over 5,000 feet above sea level, amongst which are the Galikonda and Keverla Hills; the Hill of Sinkramkonda (5,300 feet above sea level) is situated within the season's work; *vide* margin. Teak forests were found west of the Kolab River in the Sunkom zemindary, a dependency of the Bustar State. Two considerable rivers, the Kolab and the Sileru, running in a south-westerly direction towards the Godavery.

		Description of Country.	
GALIKONDA	HILL STATION.	Latitude 18° 12′ 54″ / Longitude 82° 58′ 16″	Height 5,300 feet.
KEVERLA	DO.	Latitude 18° 9′ 2″ / Longitude 82° 57′ 59″	Do. 5,144 „
SINKRAM	DO.	Latitude 18° 23′ 28″ / Longitude 82° 56′ 5″	Do. 5,300 „
ARMA	DO.	Latitude 18° 13′ 41″ / Longitude 82° 45′ 58″	Do. 5,500 „

107. The area of final topography obtained covers an area of 2,003 square miles for Atlas sheet No. 93, all of which, the Deputy Superintendent states, is carefully surveyed, and the nature of the ground well and faithfully delineated in the season's maps; in fact, that officer characterises the detail survey as of the highest standard yet attained by his party, which is very encouraging. A good step has been taken in advance in dealing with the extensive area remaining in this neighbourhood for survey. A few seasons more will bring it as far south as the Godavery Talooks and Rajamundry District limits of former surveys, and the triangulation will now connect on the Great Trigonometrical Beder Longitudinal Series, extending along the parallel of 18° north latitude,

Season's out-turn.

But there is still a very large area remaining to be provided for west of the meridian of 81° 30 as far as the limits of the Chanda District of the Central Provinces, consisting of various zemindaries, all of the very worst physical aspect.

108. Theodolite observations were taken at 42 stations, by which 109 additional points were fixed within the triangulation of previous seasons, and the elevations of 99 points were trigonometrically determined.

Recess duties.

109. The whole party returned, during the months of April and May, to recess quarters at Ootacamund, where the usual mapping and computation were completed.

Cost of the season's operations.

110. The total cost of the season's operations under the heads of establishment and contingencies, amounts to Rs. 62,615 from 1st October 1871 to 30th September 1872.

Remarks on the season's out-turn.

111. Considering the nature of the country brought under survey, which is wild and unhealthy in the extreme, and the shortness of the period when alone the party are able to remain in the field, the out-turn is a fair average season's work, and it has been well squared up, and rendered in a compact and satisfactory form creditable to the whole party.

Programme for ensuing season.

112. During the present season (1872-73) the triangulation in advance will be completed and filled up with additional points down to the parallel of 17° 45′, and the topographical delineation of the country between 18° and 18° 15′ in continuation of last season's work will be completed as far as possible.

113. Mr. R. W. Chew, 3rd Grade Surveyor, long the senior assistant in this party, was necessarily transferred at the close of the recess season to help to form No. 2 Survey, Khandesh and Bombay Native States, where the services of an experienced Surveyor were much needed, and the new appointments marginally noted were effected to complete the strength of this party. The Sub-Surveyors are promising lads from the Ootacamund Lawrence Asylum, whom it is hoped to train up for Assistant Surveyorships. I am most desirous of holding out good prospects to such lads of this noble institution as may prove qualified to pass the prescribed examination, and to offer them the chance of learning an honorable and useful profession.

Mr. Geo. Vander Beck, 4th Grade Assistant Surveyor, from 1st July 1872.
„ D. Campbell, „ W. Chapman, „ Donald Campbell, } Sub-Surveyors, { from 3rd July 1872. „ 15th do.

114. Colonel Saxton states that during the past season, he suffered very much from climatic influence and returned to recess quarters greatly shaken, from which he has scarcely recovered yet. He thinks it unlikely that he will be able to take the field again another year, as he contemplates furlough when the results of his current season's operations are all completed and rendered. This officer has had a very long service in the highly unfavorable and unhealthy tracts which have fallen under his operations, and he has been wonderfully successful in maintaining his own as well as the health of assistants, under every description of drawback and difficulty. Recessing in a good hill climate has alone enabled the party to effect such out-turns of work annually, and every credit is due to the Deputy Superintendent for his tact and able management in the field.

115. Useful notes by the Deputy Superintendent and Messrs. Harper and May, Surveyors descriptive of the country visited by them, are given in the Appendix.

No. 4.—TOPOGRAPHICAL SURVEY.

North-Eastern Division, Central Provinces.

116. Owing to the very unhealthy nature of the country in which the operations of this party for the season under review lay, it was not allowed actually to commence field-work before the month of December, by which time the forest tracts in the district of Mandla and the northern portions of the Belaspur District, are believed to be comparatively healthy. The field camp was formed at Jubbulpur, and after the completion of all necessary arrangements for a long campaign in a very inhospitable country, the several detachments started for the ground, respectively allotted to each, by the 13th November.

The Zemindaries or Estates of Kenda, Lafa, Pendra and Mahtin in District Belaspur; Pergunnah Ramgurh of District Mandla, Central Provinces, and the Taluk of Sohagpur of the Native State of Rewah.

Strength of Party.

Major G. C. Depree, Deputy Superintendent, 1st grade, in charge.		2,100	square miles of triangulation.
Mr. G. A. McGill, Surveyor, 2nd Grade, on leave.			
„ J. Vanderputt, do., 3rd do., sick leave from 23rd January 1872 to 20th June.		31	square miles topography.
„ A. G. Wyatt, Assistant Surveyor, 1st grade	...	279	ditto.
„ A. James, ditto ditto, 2nd do.	...	353	ditto.
„ J. A. Barker, ditto ditto, 2nd do.	...	287	ditto.
„ J. H. Wilson, ditto ditto, 3rd do.	...	300	ditto.
Baboo H. D. Dutt, Sub-Surveyor	...	273	ditto.
Sheikh Eusuf Shareef, ditto	...	350	ditto.
Sheikh Omer, ditto	...	280	ditto.
Baboo M. S. Dutt, ditto	...	302	ditto.
Imam Shareef, ditto	...	136	ditto.
Total square miles	...	2,591	topography.

117. The Deputy Superintendent in charge (Major G. C. Depree) commenced the triangulation in advance from a secondary side of the Jubbulpur Meridional Series ("Churia" to "Bijagar") of the Great Trigonometrical Survey, within easy reach from Jubbulpur, and thus lost no time in starting field-work. The ground over which he had to triangulate was the northern portion of the Mandla District embraced the Talook or Pergunnah of Ramgurh, from about the meridian of 80° 5′ eastwards to 81° 15′, and between the parallels of 22° 45′ and 23° 22′. This ground, which may be described as a series of level plateaux covered with forest and without any commanding peaks, is extremely difficult to triangulate.

Country triangulated.

118. With praiseworthy energy and perseverance, the Deputy Superintendent, by the end of December, reconnoitred this tract, fixed stations and cleared rays to secure vision between points for two series of triangles, one running north-west for 80 miles, the other north for 50 miles, as indicating their general directions, the former skirting on the north side the plateau which forms the water-shed between the Soane and Nerbudda rivers, the second series skirting the southside of the same plateau, the two series to unite at their western extremity, and thus to form a loop and a test of accuracy. Major Depree then commenced and completed by the 18th of February the observations at 40 stations, determining the positions of 272 points, giving an average of 1 point for every 8 miles of ground, and the elevations of 166 points, or on an average 1 height for every 12½ square miles, and covering an area of 2,100 square miles, after which he ran 445 linear miles of check-routes to test the detail survey of each plane tabler.

119. The detail survey was conducted, in continuation of the work of the previous season, through about half of the talook of Sohagpur, of the Rewah State, lying to the north of Amarkantak, and in the north-western portion of the district of Belaspur (Central Provinces) in the zemindaries or estates of Kenda, Lafa, Pendra, and Mahtin, or from Longitude 81° 30′ to 82° 15′, and from Latitude 22° 30′ to 23° 30′; the area accomplished being 2,591 square miles.

Area topographically surveyed.

120. The country delineated topographically may be briefly described as the plateaux or table-lands, situated in Sheet No. 90 of the Atlas, within and about which the sources of the Nerbudda, the Johilla, the Soane, and the Mahanadi Rivers take their rise, or one of the great water-partings of the drainage into the Bay of Bengal to the east and the Gulf of Cambay to the west, and is of a very interesting character hitherto almost unknown.

Description of ground delineated.

121. The most important of these is the Mokal-pat, on which is situated the well known shrine of Amarkantak, from which the Nerbudda River rises, and within two miles of which the Johilla River has its source. The highest point of this plateau is 3,860 feet above sea-level. The second is the terre-plein of Pendra, Chateesgurh, and Sohagpur, to the south of which, at an elevation of 2,100 feet, is the source of the Soane River. The third plateau, or level, forms part of the Kenda State in District Belaspur, the waters of which drain into the Mahanadi River; Kenda is 1,150 feet above sea level.

122. For some slight further description of the country under survey, see extract, in Appendix, from the Deputy Superintendent's report, but it has not been sufficiently explored or examined yet to admit of a full statistical or geographical account being rendered. A systematic account of fords, ferries, and passes has been arranged to correspond with the standard sheets in the tabulated form required by the Quarter Master General of the Army; this will be rendered in due time.

123. By the end of April field-work closed, and the party returned by detachments to Jubbulpur, where the depôt is formed, and proceeded to Mussoorie for the recess.

Recess season.

124. The total cost of the season's operations, under the heads Establishment and Contingencies, amounts to Rs. 53,637.

Cost of the season's operations.

125. The total out-turn of the season, *viz.*, 2,100 square miles of triangulation and 2,591 square miles of topography, is very good, and, but for the absence on medical leave of the two Senior Surveyors (*vide* margin), would have been considerably more. The loss of the two best and most experienced Surveyors for the whole of the field season was a most serious drawback, but the excellent arrangements of the Deputy Superintendent, which have secured, in a very difficult country and at a very moderate cost, a fair out-turn of work, with an establishment considerably weakened, deserve high commendation.

Opinion on the season's outturn and cost.

Mr. G. A. McGill, Surveyor, 2nd grade. Leave, on medical certificate, from 1st November 1871 to 29th February 1872. Rejoined the party in Recess Quarters on the 7th May 1872.

Mr. J. Vanderputt, Surveyor, 3rd grade. Leave, on medical certificate, from 23rd January 1872 to 20th June.

126. The fair mapping rendered is well executed generally and improved in many respects; its relative value in comparison with the results of other parties has been separately commented on.

Changes in personnel of party.

127. There is no Assistant Superintendent attached to this party, because the exigencies of the Department and the great demand for competent agency elsewhere will not permit it. Mr. A. G. Wyatt, Assistant Surveyor, 1st grade, and Sub-Surveyor Sheikh Omer were drafted to supply the wants of the new No. 2 Survey during the month of August 1872. The party was strengthened by the new appointment of Messrs. Rourke and Read,* qualified candidates, and of Sub-Surveyor, Shere Shah, to fill a vacancy in the subordinate class of Sub-Surveyors.

* Appointed from 1st October 1872.

Programme for ensuing season.

128. During the season now current, the Deputy Superintendent, Major Depree, assisted by Mr. McGill, will execute the triangulation in advance of details of the central portion of the Mandla District, and the western zemindaries in District Belaspur, (Pandaria, Kawardha, &c.) or between the parallels of 21° 50′ and 22° 45′, and the meridians of 80° 30′ and 82°. The topography of the remainder of Sohagpur (western half) and of the Amarkantak or Mekal-pat in district Mandla, together with some of the zemindaries north-west of Belaspur, will be taken up.

Inspection of party.

129. The party was inspected by myself at Jabbulpur in November 1871, and I was favorably impressed with the good management of the Deputy Superintendent, the orderly manner in which all the records were kept up, and the state of the instrumental and field equipment was all that could be desired.

130. With the exception of the Deputy Superintendent, all the members of the party suffered from, more or less, malarious fever throughout the field season, and two of the native establishment died. Messrs. McGill and Vanderputt were both unable to perform field duty during the whole of the season, and were absent under medical certificate. The country is one of the very worst for survey, but I am happy to say that the health of the establishment has been restored by a hill climate during the recess, and it has again taken the field with every prospect of success.

No. 5.—TOPOGRAPHICAL SURVEY.

Bhopal and Malwa Native States.

131. The camp of this party was formed at Hoshungabad, the field depôt station, by the end of October, and the several detached parties under the Deputy Superintendent in charge, Captain R. V. Riddell, R. E., moved into Bhopal territory north of the Nerbudda River, during the first week in November 1871.

The eastern portion of Bhopal, southern portion of Gwalior, Kurwai, Mohamedgurh, Nawab Basoda, and Pathari in the Bhopal Political Agency.

	Topography.	
Captain R. V. Riddell, R. E., Deputy Superintendent, 3rd grade, in charge ...	125	Square miles and check routes.
Captain J. R. Wilmer, Assistant Superintendent	51	Square miles and 84 miles of check routes.
Mr. A. J. Wilson, Surveyor, 4th grade ...	298	Square miles and 56 miles of check routes.
,, C. F. Hamer, Assistant Surveyor, 1st grade ...	361	Square miles.
,, A. W. Chennell, ditto, 2nd ditto ...	307	ditto.
,, C. Kirk, ditto, 2nd ditto ...	233	ditto.
,, E. A. Wainright, ditto, 2nd ditto ...	351	ditto.
,, H. T. Kitchen, ditto, 3rd ditto ...	365	ditto.
,, W. H. Lilley, ditto, 3rd ditto ...	384	ditto.
Sheikh Nubbi Baksh, Sub-Surveyor	368	ditto.
Prem Raj, ditto, ...	115	ditto.
Abdur Rahim, ditto, ...	176	ditto.
TOTAL ...	3,124*	Square miles.

* Of this 229 square miles was overlap survey, taken up to establish a proper junction with the work of Revenue Surveys in Saugor, Narsingpur, and Hoshungabad long previously executed.

132. The triangulation in advance executed in the previous season in Bhopal (4,267 square miles), while the detail parties were employed in completing the topography of the unfinished portions of the Bundelkund States, together with that south of latitude 24° (equal 3,200 square miles) made over to this party from No. 1 Gwalior and Central India Survey, for reasons assigned in para. 70 of my last printed report, gave a total of 7,467 square miles of advanced triangulation within the new field allotted to this survey, thus rendering it unnecessary to undertake further work of this description during the season under review; the entire strength of the establishment was therefore employed on topographical delineation of the ground, limited on the south by the Nerbudda River, on the east by the boundary of the British district of Saugor, on the west by the meridian of 78°, and on the north by the parallel of 24°, embracing about one-third of the Bhopal State under the Nazims of Raiseen and Kulliakheree, with a small portion of Sindiah's territory in the Mangouli Soubadaree, Tehsils Bhilsa and Basoda, and the petty states of Kurwai, Mohamedgurh, Nawab Basoda and Pathari, much intermixed with Gwalior territory, but under the Bhopal Political Agency.

133. The total area of final survey completed was 3,124 square miles, of which 2,172 square miles belongs to Bhopal, 590 square miles to Gwalior territory, 30 square miles to Mohamedgurh, 40 square miles to Nawab Basoda, 16 square miles to Pathari, and 32 square miles to Kurwai.

Area accomplished.

134. The area under actual cultivation was found, on an average, to be about 60 per cent., the villages were numerous, the population in proportion, and the soil of the cultivated tracts rich and very productive. Diagonally across the season's surveys runs the Vindhya range, the general elevation of this portion being about 1,800 feet above sea level, while occasional peaks and ridges rise to nearly 2,400 feet.

Description of country.

135. This country is drained to the south by the Rivers Sindor, Tendoni, and Banna, feeders of the Nerbudda, and on the north and east by the Betwa, Binna, Dassan, and Beas. The estimated fall of the bed of the Nerbudda River between the meridians of 78° and 79°, is about one foot per mile.

136. In the Nerbudda Valley, during the month of April, the heat is represented as more than usually severe, the thermometer in the shade in a large tent registered 109° Fahrenheit. The field work then closed, and the party returned to recess quarters at Mussoorie, when the mapping and other duties were completed.

Recess season.

137. The total cost of the season's operations for establishment and contingencies, amounts to Rs. 58,157.

Cost of the season's operations.

138. The season's out-turn is very good, the party having been employed in country new to all the Surveyors, and differing considerably from that in Bundelkund which they had just left. The results are highly creditable to Captain Riddell and his assistants; the maps and other records have all been brought up and rendered systematically, and bear a very good comparison with those produced by the other parties. The testing of the topographical details in the field and supervision of the plane tablers has been excellent. The valuable services of Captain Wilmer, Assistant Superintendent, were unfortunately lost for three of the best working months owing to severe illness, which necessitated that officer taking leave under medical certificate from the 19th December 1871 to the 2nd March 1872. The Assistant Superintendent's previous and subsequent good services were brought to the notice of Government, and he received his promotion to 1st grade from the 28th August 1872, by orders marginally noted. Captain Wilmer is a most promising officer and fully qualified for the charge of independent survey operations.

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Notification No. 655, dated the 10th October 1872.

139. In the Appendix, extracts from the Deputy Superintendent's report will be found descriptive of the country surveyed, and a memorandum on the forts (existing or in ruins) met with. A statemant or schedule of fords, ferries, and mountain passes in the country visited by the Deputy Superintendent, was prepared and duly forwarded to the Quarter Master General of the Army.

140. The services of another experienced Assistant Surveyor being suddenly needed for one of the Eastern Frontier expeditions, Mr. A. W. Chennell was transferred to No. 6 Khasia and Garo Hill Party. Mr. C. Kirk, Assistant Surveyor, was permitted, after the whole of the work was brought up, to resign his appointment. To fill these vacancies, Messrs. J. Murray and A. Kitchen, duly qualified candidates, were posted to the party as 4th Grade Probationary Assistant Surveyors, from the 1st November 1872.

Changes in personnel.

141. During the current season, the detail survey of the country between the meridians of 77° 30′ and 78°, and parallels of 23° and 24° in Bhopal, Oojein, and Nursingurh territory in Square Degree No. III, will be taken up, together with a large scale survey of the city and environs of Bhopal and Sehore. The triangulation in advance will be extended westwards in Square Degrees Nos. III and IV from the vicinity of the city of Bhopal, and a series of first class triangles will be carried along about the parallel of 23°, to connect the Great Arc Series with the Khanpisura Series, Great Trigonometrical Survey, or from about longitude 78° to 75°, as well as to combine with the triangulation of the Khandesh Survey by No. 2 adjoining party. As the space between the Great Arc and the Khanpisura Meridional Series south of the western or Kurrachi Longitudinal Series is very large for the extension of secondary triangulation only, it is intended to run a first class secondary series on the high ground between the two meridional series, somewhere between the south of Bhopal and Indore or Mhow, to give a good basis for future extension into Square Degree No. VI resting on the Nerbudda River.

Programme for ensuing season.

No. 6.—TOPOGRAPHICAL SURVEY.

Khasia and Garo Hills.

142. This party was diverted from the field of its regular operations in the Garo and Naga Hills, to provide a competent staff of surveyors to accompany the Lushai Military Expeditionary Field Force, left or Cachar column, on a special requisition of His Excellency the Commander-in-Chief, *vide* paragraphs 120 and 121 of my last printed report, season 1870-71.

Eastern Frontier of Bengal.
Portions of the South Cachar and Lushai Hills and Munnipur State.

Captain W. F. Badgley, S. C., Officiating Deputy Superintendent, in charge.
Lieutenant R. G. Woodthorpe, R. E., Assistant Superintendent.
" E. P. Leach, R. E., ditto ditto.
Mr. M. J. Ogle, Assistant Surveyor, 1st grade.
" W. Robert, ditto, 4th "
" J. McCay, ditto, 4th "

143. With the object of placing the Government of India in early possession of the results of the survey expeditions on the Eastern Frontier, which accompanied the military columns under Brigadier Generals Bourchier and Brownlow from the Cachar and Chittagong sides, into the hills beyond the British Frontier, inhabited by the Lushai, Kuki, Sylu, Shendu, Howlong, and other minor tribes of semi-savages, a report was submitted (*vide* my special report No. 160F., dated the 22nd June 1872, reprinted in the Appendix) of the combined operations conducted by the two independent survey parties under the superintendence of Major John Macdonald, Officiating Deputy Surveyor General, and Captain Badgley, S. C., Officiating Deputy Superintendent of Survey, respectively, which with its enclosures was separately printed, and likewise published in full, by order of the Governor General in Council, in an extra supplement to the *Gazette of India*, dated 8th November 1872.

144. It is not necessary in the present place to go into the whole of these professional details again, on which the final review and orders of the Government of India have been passed, but with the object of rendering in a complete form the general results of the operations and administration of topographical surveys for the season under review, the work performed by No. 6 Survey under Captain Badgley's superintendence is briefly recorded here, in order to preserve the departmental history of survey events. Such portions of the statistical and geographical information which are of immediate value and interest of this hitherto unknown territory, are extracted in the appendix.

Vide Resolution of the Government of India, in the Department of Agriculture, Revenue and Commerce, No. $\frac{2}{562 \text{ to } 576}$, dated 13th September 1872, in the Appendix.

145. Emanating from a side of the Great Trigonometrical Secondary Series in South Cachar the secondary triangulation accomplished extended about 25 miles in a south-eastern direction over 612 square miles, and to this must now be added 1,544* square miles of tertiary triangulation, or points determined by intersections, giving a total of about 2,156 square miles of country thus covered. The most easterly position fixed is in Longitude 93° 3', and the most southerly in Latitude 23° 32'. The elevations of 65 points were trigonometrically determined, and the points reached ranged from 4,925 feet to 6,850 feet above sea level.

Season's out-turn triangulation.

* The area covered by tertiary points could not be given until the computations were completed and the points verified by common sides.

146. An area of 6,068 square miles based on the above triangulation, and including overlaps route survey, was topographically surveyed on the $\frac{1}{4}$ inch, or 4 miles = 1 inch scale. The actual area for which new geography was secured being about 4,800 square miles. In addition to this a route survey on the scale of 1 inch=1 mile was made of the line by which the force advanced, and between outposts in South Cachar, or over 191 linear miles of most difficult ground in an enemy's country.

Topography obtained.

147. Unfortunately, however, time did not permit of a junction between the northern and southern columns before the expiration of the military operations, when the country was rapidly vacated. A considerable gap, therefore, still exists, which it is most desirable to fill up, to enable us to complete the general geographical configuration of the Eastern Frontier, and of the extensive tract lying between the Cachar, Sylhet, Tipperah, and Chittagong British Districts. The total results obtained by the two combined parties with the military expedition, are given in my special report on this subject in the Appendix.

148. The total cost of the entire season's operations for this party amount to Rs. 47,073, which, considering the special nature of the work performed in a difficult and hostile country, with the exorbitant wages of coolies and the absence of all other means of transport, is exceedingly moderate. The recess duties were performed at Shillong.

Cost of the season's operations.

149. The operations of this party during the season may fairly be considered as most successful and encouraging. Reliable geography for a considerable area beyond the British Frontier has been obtained, and politically, we have gained very valuable information regarding various frontier tribes, who have long proved most troublesome neighbours. Our ignorance of their habits, manners, and, relations with each other, have, in a great measure, hitherto prevented proper

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communications being opened and intercourse with them, but with the knowledge now gained both as regards the country and the people, it is hoped more friendly relations will soon be established, and further opportunities be offered of gaining a complete knowledge of the *terra incognita* between Burmah and our eastern districts, which has long defied the efforts of all explorers on the Eastern Frontier.

150. The sources of the Tipai or Tin-Vi and its chief tributaries and the head waters of the Kolodyne River are now known. Captain Badgley describes the scenery in the interior of the Lushai Hills and at the higher elevations visited as "magnificent." The fir, rhododendron, and oak take the place of bamboo and low heavy jungle, and the climate is healthy and invigorating.

151. The recommendations made for prosecuting the survey of the remaining blanks, having been approved of by the Government of India, arrangements were timely made for another expedition under the excellent management of Captain Badgley, who is now actively employed in exploring the country along the Jampoi, Hachik ranges, one of which is supposed to form the eastern boundary of Hill Tipperah, or the territory of the Rajah of Tipperah, which it is desired to fix definitely in connection with the larger question of a continuous line of British Frontier from Assam to Arracan. Other special and very urgent surveys on the Eastern Frontier in three different directions have likewise been called for, which has taxed the resources of the department; the party having been strengthened, has now been divided into four widely separated detachments.

152. The return of Major Godwin-Austen, Deputy Superintendent, some months after the expiration of his two years' furlough to Europe, and his reappointment to the Department as junior of his former grade, by the orders marginally noted, placed at my disposal the services of an experienced officer well qualified to undertake the work on the extreme north-east for the exploration of the Patkoi range, for the purpose of defining a disputed boundary with the Munnipur State, in continuation of the regular survey brought up from the west through the Khasia, Jynteah, and Naga Hills.

* Agriculture, Revenue, and Commerce Department, No. 677, dated the 18th October 1872.

153. These detachments of No. 6 party and the work allotted to each are as follows:—

1ST DETACHMENT.—

Major Godwin-Austen, Deputy Superintendent, in charge.	To survey the Naga Hills and Munnipur boundary, and explore the Patkoi range.
Mr. Ogle, Assistant Surveyor, 2nd grade. „ McCay, ditto, 4th „	To carry on the old survey of the Mekir and Rengmah Naga Hills south of the district of Nowgong and north of the previous work in North Cachar and Samagooting.

2ND DETACHMENT.—

Captain Badgley, Officiating Deputy Superintendent, in charge of Special exploring party. Mr. A. Chennell, Assistant Surveyor, 1st grade, transferred from No. 2 Topographical Party.	To explore and survey the Jampoi and Hachik ranges between Hill Tipperah and the Lushai Hills, with portions of the north Chittagong Hills and the southern and western portion of the Lushai Hills, to fill up the blank left last season.

3RD DETACHMENT.—

Lieutenant Woodthorpe, R. E., Assistant Superintendent. Mr. W. Robert, Assistant Surveyor, 3rd grade. Surveyors Shah Nasirudin and Dalihudin.	To accompany the police force expedition under Captain Williamson, Political Agent, for the triangulation and survey of the Garo Hills and western boundary between the Garo Hills and District Goalpara, with the view of completing all that previously remained of these hills, and especially of those portions hitherto termed independent, and which have never been entered or explored in any way.

4TH DETACHMENT.—

G. H. Cooke, Esq., Assistant Superintendent, Revenue Survey, previously employed with the party accompanying Brigadier General Brownlow's southern column, but specially for the occasion.	To explore the ranges south of Demagiri, in the Chittagong northern hills, with a view to adopting a continuous frontier line of defensive boundary down to the known limits of Arracan in the Akyab District of British Burmah, and to obtain as much information as practicable for filling up and correcting the meagre or imperfect topography in that direction.

154. These various and important operations of a particularly arduous character are now all in full force, and, I am happy to say, with every prospect of success in each case. The hardships and difficulties being experienced are very considerable, but the energies and abilities of the officers and assistants employed will, I am sure, be equal to this occasion, as they so eminently proved last season.

155. There will still much be left to get through on the North-East Frontier in the Naga country and towards the valley of Assam, for which I trust the uninterrupted services of the whole party will again be available next season, and under the able management of Major Godwin-Austen, who is so thoroughly acquainted with this part of the country, and who is such an accomplished explorer, the best results may be anticipated.

156. Lieutenant Leach, R. E., Assistant Superintendent, who was temporarily employed with this party on the military expedition, having completed all the work entrusted to him, was posted to the Gwalior party to supply the vacancy therein caused, and he joined it at Mussoorie in June 1872.

157. On the conclusion of the current season's field work, it will be necessary to make arrangements for the transfer of Captain Badgley, Officiating Deputy Superintendent, who has been relieved of the charge of No. 6 party by the return of Major Godwin-Austen. In consideration of the importance of the special duty on which Captain Badgley is now engaged, he has been allowed to retain his officiating position and salary until the completion of his work.

158. The successful exertions of Captain Badgley and his party and the valuable contribution thus made to the geography of the Eastern Frontier, under the favorable auspices of the military occupation of the country during the past season, were prominently brought to notice in my special report above quoted, and acknowledged by the Government of India, as well as by the Secretary of State for India, as recorded in the documents in the Appendix. There can be no doubt as to what the whole party had to go through, and with what devoted zeal and willingness both officers, assistants, and the men of the party worked under very adverse circumstances, not only throughout the military campaign, but for a considerable period afterwards, immediately south of the Cachar District boundary, until they returned to recess quarters very late in the season, with such satisfactory and important results. The officers and assistants named in the margin, are specially deserving of praise and encouragement for highly meritorious services.

Despatch No. 34, dated 28th November 1872.

Captain Badgley, Deputy Superintendent.
Lieutenant Woodthorpe, R. E., Assistant Superintendent.
Lieutenant Leach, R. E., ditto ditto.
Mr. Ogle, Assistant Surveyor.
" Robert, ditto.
" McCay, ditto.

No. 7.—TOPOGRAPHICAL SURVEY.

RAJPUTANA.

159. A detachment from this party, under the Assistant Superintendent Mr. H. Horst, started from recess quarters at Mussoorie on the 25th September 1871, to triangulate very closely the country around Delhi required by the Quarter Master General's Department, to give fixed points at close distances on which the plans of the Camp of Exercise, on a large scale, 4 inches = 1 mile might be based *(vide* paragraph 132 of my printed report for season 1870-71), and this work was very successfully completed, and the triangulation chart rendered with sufficient data for the purpose by Mr. Horst, by the beginning of December 1871.

Portions of the Native States of Udeypur or Meywar, Jodhpur or Marwar, and the British Districts of Ajmere and Mhairwara, within the Rajputana Political Agency.

STRENGTH OF PARTY.

	Topography.	Triangulation.
Captain George Strahan, R. E., Deputy Superintendent, 2nd Grade, in charge ...	165 Sq. Miles.	940 Sq. Miles.
H. Horst, Esp., Asst. Supdt.	...	2,000 "
Mr. R. Todd, Asstt. Surveyor, 1st Grade ...	227 "	
" C. Tapsell, " 2nd " ...	297 "	
" F. Kitchen, " 2nd " ...	243 "	
" W. Stotesbury, " 2nd " ...	230 "	
" W. McNair, " 3rd " ...	360 "	
" P. Warde, " 4th " ...	255 "	
Sub-Surveyor J. Nath ...	210 "	
" Kalka Pershad ...	315 "	
" Harlall Singh ...	310 "	
TOTAL	... 2,612 Sq. Miles.	2,940 Sq. Miles.

160. As the result, we have most interesting and valuable maps of the country to the north-west and south of Delhi, surveyed and drawn for the most part by the officers of the Quarter Master General's Department, which never existed before, and which will remain a most interesting and useful record of the military manœuvres conducted in the cold season of 1871-72, under the personal command of His Excellency the Commander-in-Chief of the Army, Lord Napier of Magdala. These maps, as prepared by the Quarter Master General's Department, were published by this Department in a very practical and satisfactory manner, and I had great pleasure in thus co-operating with the Quarter Master General of the Army in so important a matter.

161. The remainder of the party under Captain George Strahan, R.E., Deputy Superintendent, in charge, proceeded to Agra, the field depôt of this survey, and formed camp there by the middle of October, when the field equipment being completed, the party reached the ground allotted for survey by the first week in November.

Triangulation.

162. The ground requiring triangulation embraced small portions of Jodhpur and Udeypur territory, within the Degree Square No. VIII (about two-thirds of it) formed by the parallels of 25° and 26°, and the meridians of 73° and 74°, covering an area of 2,940 square miles, of which 940 square miles were triangulated by Captain George Strahan, Deputy Superintendent, and 2,000 square miles by Mr. H. Horst, Assistant Superintendent; 57 secondary and 398 minor secondary triangles were obtained, and the elevations of 445 points determined.

163. In addition to the above, Captain Strahan ran 302 linear miles of check-routes, and Mr. Horst completed nearly 17 linear miles of traverse along the western side of the Sambhar Lake.

Topography.

164. The ground delineated during the season covers an area of 2,612 square miles between the parallels of 25° and 26°, and the meridians of 74° and 75°, and includes portions of Jodhpur, Udeypur, the petty states of Bednor and Deogarh, a small portion of the District of Ajmere, and nearly half of Mhairwara, as contained in the Square Degree No. VII.

Description of country.

165. The Arabulla or Aravalli mountains runs through the eastern side of the country triangulated. Its greatest breadth was found to be about 20 miles from east to west, and the range is believed to attain its greatest altitude here, the peak named "Jargo" being 4,330 feet above sea level and only second to the peaks of the Abu plateau further south, of which "Gurusikkar" (5,653 feet above sea level) is the highest.

166. The Arabulla range forms one of the most important water-partings in this part of India, the drainage from the eastern side flowing into the Banas, which joins the Chambal River further east, while the waters on the western side form the sources of the Luni River draining into the Runn of Cutch. The country on the east of this range is from 800 to 900 feet above the level of that on the western side. Rising gradually from the plains of Meywar or Udeypur, the country is more or less broken up by little masses or hillocks of rock until a plateau is reached, from which rise parallel ridges, nearly precipitous on both sides, forming narrow valleys between, while on the Jodhpur or Marwar flank the fall is abrupt, the features more massive and covered with dense jungle. More intricate or difficult ground perhaps cannot be met with, as the extraordinary minuteness of the features on the maps testify, and thus completely altering the old maps of this district and placing the character of the ground on an entire new footing.

167. The special objects brought to notice by Colonel Brooke, Agent to the Governor General for Rajputana, for the purpose of drainage works in Mhairwara, caused great care and minuteness to be employed in shewing every detail of which the one-inch scale was capable, and it is hoped that the maps now rendered will materially tend to provide the necessary information for this peculiar and wild tract of country.

168. With the object of utilising the services of this party to the utmost during the recess as well as in the field season, the large scale survey of the Simla Sanitarium (referred to in paragraph 133 of my last printed report) was commenced before the rainy season set in, the field work in Rajputana, which consists of a very excellent average out-turn, was closed by the end of March, and the party proceeded *viâ* Agra, being well instructed in traverse surveying, *en route* to recess quarters at Simla.

Commencement of the survey of Simla.

169. Early in April, therefore, Captain George Strahan was enabled to start the minor triangulation, which forms the ground-work for the plan of Simla, on the large scale of 24 inches to the mile*, obtaining the initial values for his triangulation from the old stations of the Great Trigonometrical Survey, North-West Himalaya Series, "Shali" to "Phagu," from which a net-work of secondary and minor points were fixed in and around the sanitarium connecting with "Jakho" (altitude 8,059 feet) and "Observatory" (altitude 7,089 feet) stations, numbering in all 32 secondary stations and 169 intersected points, with the elevations, trigonometrically determined, of 83 points.

* or 220 feet=1 inch; natural scale $\frac{1}{2640}$.

170. Main traverse lines by chain and theodolite were then run along the principal roads, connected at the starting and terminal points with the triangulation; and these being plotted by computed co-ordinates on the plane tables, the details of the ground were taken up by a succession of minor traverses, on plane table bearings and chain measured distances, depending on and fully checked by the stations of the main traverse lines.

171. No less than 31 linear miles of elaborate main traverse lines with off-sets, were measured along roads in a small area of about six square miles, the chained distances along hill slopes having been reduced to horizontal measurements.

172. Each plane table field section contains a square of 2,500 by 3,500 feet, and four of these form, when combined and fair-copied, one standard sheet. The field work for seven of these standard sheets, representing 380 acres of ground on the 24-inch scale, has been completed, and six have been fair-drawn and rendered to this office, of the portion of Simla south and south-east of "Jacko Hill," containing "Chota Chelsea" and "Chota Simla," "May Day Hill" and the Band-stand.

173. The Simla and Jatog Sanitarium will be represented on 20 standard sheets, each measuring within margins 22·7 by 31·8 inches, and it is expected that the drawing of the 24-inch scale will be susceptible of producing good reduced sheets on a scale of 16 inches to the mile.

174. A first or preliminary edition of these sheets are under issue at present for immediate local purposes only, as the boundaries of the numerous estates have not yet been entered, and in many instances are not defined by permanent pillars or other suitable marks on the ground; this, however, is now being done by proprietors, who will have the maps to help them, and all the boundaries after adjustment of disputes will be shown on the final edition of the standard sheets.

175. The photographed copies of the original field plane table sections, taken immediately after survey, thus form most valuable documents for all local enquiries as to rights of properties, and enable us to preserve the fair maps from all risk of alteration and deterioration after execution, by the changes so constantly made in the boundaries of estates, and specially in a hill station like Simla, now so closely built over, and where private interests are so keenly contested.

176. The Simla survey field work can thus only be conducted for a very short period, both before and after the rainy season, while the party is in recess quarters and can devote spare time from its other duties; the actual working period is, therefore, necessarily limited to about three or four months.

177. To lay out and complete the secondary triangulation for the commencement of the detail delineation of ground was no ordinary labor, but Captain George Strahan, with his usual ability and energy for which he is ever conspicuous, ably aided by the Assistant Superintendent Mr. Horst, and an excellent staff of assistants, succeeded in all he undertook, and before the rains set in finished most of the observations and measurements for the triangulation and traverse lines, and then started the plane tablers for laying down the topographical details on a suitable system of drawing for so large a scale.

178. The six standard sheets completed, of which three have been fair-drawn by Captain George Strahan and three by Mr. Assistant Surveyor Stotesbury, are admirably finished specimens of hill drawing on a large scale, and faithfully represent the ground. The labor of drawing these sheets is very great, the requirements of reproduction and reduction by photography necessitating the whole being done in pen and ink, which demands first-rate artistic ability, so as to preserve the tone or relative command of the hill features.

Cost of the season's operations.

179. The expenditure for the season for establishment and contingencies from 1st October 1871 to 30th September 1872, both for the Rajputana and Simla surveys, including the bringing up of both, amounts to Rs. 58,641. The expenses of the Simla survey are consequently very little above the ordinary charges of the party during the recess.

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180. The whole season's operations have been of a very arduous character, without any intermission, but most successful; and whilst the results obtained are excellent, the cost is very moderate, especially when the additional results obtained during the recess season is considered. The expenditure has been well controlled and utilised to the utmost extent, with the greatest possible resulting advantage.

Programme for the ensuing season.

181. The triangulation in Rajputana being well in advance of details nearly the full strength of the party will be employed on plane tabling, within the eastern half of Degree sheet VIII between the meridians of 73° 30' and 74°, and the parallels of 25° and 26°, in portions of Jodhpur, Udeypur, and Mhairwara. To admit of the continuation of the Simla survey, the prosecution of which is very important, the party will square up the Rajputana work and proceed to Simla early in April, immediately to go on with the hill drawing there in the fine weather before the rains set in.

Personnel.

182. Captain Strahan states that Mr. Horst, Assistant Superintendent's duties this year have been very various, and in everything that he has undertaken he has given as usual the most unqualified satisfaction, both as regards field and recess work. I have great pleasure in again testifying to the value of this Assistant Superintendent's services. Messrs. Tapsell and McNair, Assistant Surveyors, are likewise entitled to special mention for zealous and highly efficient services, for which both have received departmental promotions to a higher grade.

Mr. P. White, Probationary 4th Grade Assistant Surveyor.
" George Copping, Apprentice Assistant Surveyor.
" T. Downes, Sub-Surveyor.
" E. Graham, ditto.

183. To fill existing vacancies in the Department, and to secure the full advantage of the excellent training and tuition which every member of this survey receives, under the able management of Captain George Strahan, the postings marginally noted took effect from 1st October 1872. Messrs. Downes and Graham, two promising lads with the required qualifications, joined from the Sunawar Lawrence Asylum, and I trust they are in a fair way of learning a profession which ought to be of the greatest value to them.

H. L. THUILLIER, *Colonel*,
Surveyor General of India.

SURVEYOR GENERAL'S OFFICE,
Calcutta, January 15th 1873.

APPENDIX.

APPENDIX A.

REMARKS, PROFESSIONAL, GEOGRAPHICAL & STATISTICAL,

BY

EXECUTIVE OFFICERS.

Extract from the Narrative Report of LIEUTENANT T. H. HOLDICH, R. E., *Assistant Superintendent, Offg. in charge No.* 1 *Topographical Survey, Gwalior and Central India.*

Gawlior and Tonk &c.
Latitude 24°to 24° 45'.
Longitude 78°to 78° 20'

The country surveyed in detail by this party in Degree Sheet VIII which comprised the valley of the Betwa river on its left bank, has already been fully described. It is an intricate, forest-covered country in the neighbourhood of Chandairi and for a considerable distance south of it; but the Mangouli and Kurwai country is open and fertile. Provisions were cheap, and the survey work proceeded with comparatively little difficulty.

Latitude 24° to 25°
Longitude 77° to 77° 30'

The four standard sheets comprising the western half of Degree Sheet IX, which were completed in detail this year, include a large proportion of unusually troublesome country to work through. The head of the Kunu valley, a mass of precipitous scarped hills covered with a stunted growth of jungle, and almost devoid of cultivation, forms the northern section of this half degree. From it westward the country slopes away to the Parbati river, and the intervening ground is one continuous level of uninterrupted jungle. There is not much undergrowth, though the grass is dense and high immediately after the rains. It is an unwholesome country altogether. Scarcity of water and constantly recurring famines have reduced the population to a minimum; a few half-starved cattle constitute their wealth. Their cities are now hamlets standing in the midst of ruins. The extent and nature of these ruins, however, testify to a different state of things formerly, and doubtless this poverty-stricken country could furnish matter of great interest to the Archæologist. Mr. Scanlan has added a few notes on the country which came under his immediate observation near the source of the Kunu, and has compiled an interesting history of Umri.

South of this, the country worked in detail this year may be described as the basin of the Parbati.

The eastern limit of this basin is a ridge or step from the higher plateau drained by the Sind river. The water shed of the two rivers consists of intricate and broken ground with the usual undersized tree jungle, deserted villages and scanty population.

The nature of the country which came under triangulation this season, and which will be planetabled during the cold weather of 1872-73, or between Latitude 24° and 25° Longitude 76° and 77°, may be described as large tracts of open, flat, cultivated land towards the north with plateaux of stony jungle covered hills towards the south-east. The hills to the west extend in two narrow ridges from north-west to south-east, running strictly parallel to each other at a distance of about half a mile. The valley between the ridges here and there widens and deepens, and a string of small lakes occur giving a singularly picturesque appearance to the scenery. The fortified cities of Jhalra Patan, Gahgrun, Shergarh and Nahargarh are included in this half degree. Shergarh is a large fort in a strong position and will merit particular attention when the country in its neighbourhood is surveyed in detail. Nahargarh too is a fort of considerable size but it is difficult to imagine that it could even be of importance strategically, for it is situated on a level plain closely surrounded by jungle on all sides. It has no command whatever. Gahgrun fort covers a pass between Jhalra Patan and Shergarh, but it is a small fort and the pass it covers is by no means the best across that ridge of hills; Jhalra Patan fort will be surveyed in detail with the city.

The southern half of the degree was triangulated by Mr. Bolst, who thus describes his method of triangulation and the general nature of the country:—

"In proceeding to triangulate the country comprised within the limits of 24°0' to 24°30' north Latitude and 76° to 77° east Longitude. I started my reconnoissance from the Great Trigonometrical Stations of Nandna, Sartal, Banskati and Guraria which formed the northern flank of my work, and which extended in nearly a straight line from east to west; by this means I was enabled to select five commanding points as first class secondary stations, and also to pole up all prominent hills in the country about 4 miles south of this line. I then returned in an easterly direction parallel to the route I had taken before, visiting the Great Trigonometrical Stations of Kursaipura and Matabahora on my way, and selecting stations at distances varying from 9 to 12 miles from each other and falling within the triangles of the Great Trigonometrical Station. I proceeded in this way from west to east and back again till nearly the whole area to be brought under triangulation, with exception of a small piece to the west,

had been covered over with stations on commanding sites, and a number of intersected points had been duly marked and fixed on my plane table.

"Thus far my work had progressed satisfactorily, the nature of the ground being generally hilly with conspicuous peaks cropping up above the general level, and so affording facilities for the selection of stations. It was when I got to the tract of country to north-west that I experienced my great difficulty in finding stations which could see each other. The reason was that the general run of the country was undulating and covered with heavy jungle. From a distance it appeared to be an extensive plateau, but on nearer approach proved to be of the nature above mentioned. In consequence of this I had to content myself with such sites as would under more favorable circumstances have been rejected. Having brought my reconnoissance to a close on 14th January 1872, I commenced observing on the following day and finished my observations on the 13th March at Banskati, Great Trigonometrical Station, visiting 40 stations, in all of which two had to be visited twice. I was fortunate in having favorable weather almost throughout the time I was engaged in this work. Four or five days early in February formed the only exception when a heavy mist hung over the country.

"With regard to the nature of the country brought under triangulation it may be described generally as hilly and covered with thick jungle, with the exception of a portion to the west which is level and well cultivated, quite a pleasing contrast to the surrounding uninteresting country. The districts comprised within this area are portions of Gwalior and its sub-divisions. Rajgarh and Omatwar, Tonk, Jhalra Patan and Holkar. The chief towns are Dilanpur, picturesquely situated on the precipitous bank of the Chapi river; Manohar Thana a large and important town on the Purwan river, and Bukhani. These belong to Jhalra Patan, Machilpur and Jhirapur in Holkar are situated in the plains and surrounded for a short distance only with richly cultivated fields. Kalchipur on the Ghar Nuddi belongs to Scindia and is the residence of a Raja, not a single good road is to be found in all this extent of country; mere foot paths and cart tracks traverse it, nor is a single bridge to be met with. While this state of things lasts, the traffic of these native states, which might easily be extended with advantage, will never be opened up and the resources of the country will continue undeveloped."

Mr. Scanlan thus describes the district round the immediate source of the Kunu river:—

Topographical description of Plane Table 67
Latitude 24° 45' to 25°.
Longitude 77° 15' to 77° 30'.

"This tract of ground is very nearly throughout the whole of its eastern length traversed by the Kunu river which runs due north, while towards the west the ground slopes away giving tributaries to the Parbati. The range known to us as the Kunu scarp enters the north-western section and continues on in an unbroken course till it embraces the river on both its banks as far up as Agra H. S., so that we have a valley well and clearly defined with spurs emanating from the principal range. The general aspect of the ground is of a broken-up nature traversed by multitudinous streams with detached hills crowning its plateaux; but this formation of ground exists in its greatest dimensions for only about 7 or 8 miles, after which we meet with a plateau intersected by many streams running towards all points of the compass. So that I may without incongruity speak of my middle section as the water shed of this table. The hills are sometimes very abrupt, rising to an average height of 1800 and 1700 feet above sea level, whilst their altitude above the valley is only from 400 to 500 feet, the chief characteristic to be remarked in them being the very many deeply scarped gorges. Almost all these gorges have proved a haven of safety to marauders and the mutineers of the memorable year 1857; notably one known as Kedar Kuika Kho.

"The country, with the exception of a few square miles to the east and south-east, is very thinly peopled and sparsely cultivated, even where the few occasional villages do exist, and is throughout clothed with a most luxuriant growth of heavy jungle perfectly free however from any entanglement of undergrowth as found in other forests of India. The soil is very rocky, water scarce on the plateau, but abundant below, and the roads of through communication are all easily traversed by carts. At the spot known as Kedar Kuika Kho, to which I shall have occasion to allude further on, there is a small and common-place temple at the bottom of the left hand scarp which immediately begins the gorge. In the Hindu month of February a large concourse of people assembles here to pray, feast and make offerings, after the orthodox manner in honor of the presiding deity Kedarnath, *alias* Mahadeo.

"From the areas which the debris covered, I was led to the conclusion that two or three sites had once been occupied by large and populous towns, and had this opinion confirmed by the traditions of the people, but the vestiges of the ruins are very ordinary and above the surface show the existence of nothing worthy of notice in architecture. In one ruined site I was shewn large slabs with colossal human figures embossed on them; from the manner of their designs I am of opinion that they are connected with the ceremonies of the Sarangi Banias, who in days gone by must have had a very large town here, and were in all probability expelled from this locality when the hypocritical Aurangzebe carried his iconoclastic invasion throughout the length and breadth of India, for this ruthless Goth even evinced his savage zeal by defacing some of the beautiful Saracenic architecture at Fatehpur Sikri. In some other places I found engraved on slate an arm raised from the elbow perpendicular to its upper portion together with a sun, star and crescent-moon depicted. What these mystical signs alluded to I failed to find out.

"The whole of the area comprising this table is split up into little territories presided over by the petty chieftains of Bhadoura, Umri and Sirsi, the two former of whom are allied by

family ties and the incidents relating to the family of the one will quite answer for those of the other. These two collateral branches of the great Rajput family are at feud with one another, and so great is their rancour that I am of opinion nought but bloodshed would wipe out their hatred. Even in these times of the supremacy of British rule carrying with it all the wholesome dread it inspires, and notwithstanding the vicinity of a British Political in the cantonment of Goonah, only 8 and 10 miles off, these two families still practise raids into one anothers' districts, the invariable issue of which is bloodshed.

"The following narration I have obtained from the family archives of the Umri chief. The Raja is a Sisodia Rajput descended from the house of Udepur. Ude Sing is his progenitor and was after the general manner of native potentates the lusty father of an unhappy family of twenty-four sons who were always contriving to cut each other's throats. Of these Sagarji was the fore-father of the present Raja, he was the youngest son and Partab Sing the eldest, the former received as his patrimony the territory of Sirohi, whilst the latter succeeded the Rana Ude Sing, and deprived his brother of his territories. He refused to give any ear to the complaints of Sagarji who thereupon complained to the emperor Akbar, having previously enlisted the Jeypur Raja's sympathy and interest, for he had already married that chief's sister. Akbar then ordered an advance to be made on Udeypur and accompanied his forces in person. The reigning prince, Partab Sing, was expelled and Sagarji assumed the sceptre. He only reigned seven years, for at the end of that period, on account of his nephew's many amiable qualities, and seeing in him a future good ruler, he resigned the reins of Government to Amar Sing, the son of Partab Sing, and retired to the court of Jehangir, who had by this time succeeded Akbar. He was made a Dewan and received Khandar as a Jagir, and on his death was succeeded by his son Man Sing who had given to him the additional grants of land of Sapur and Toro. To him succeeded Mokam Sing with possession of Khandar only, being deprived of the two additional grants in which his father appeared only to have enjoyed a life interest.

"This prince had two sons, Sojan Sing and Chatter Sing. The latter owing to some family dissensions, took up his abode at the Imperial court, and there growing in favor, he was deputed to take command of the army proceeding against Cabool. He defeated the enemy at Ghazni, and in recognition of these services the emperor conferred titles on him, and made him Lord of 60 villages or 5 barais namely, Tharonto, Mendpur, Badarwas and Nagdo; the remaining barai somehow he did not get possession of, it is said to have been situated somewhere near Anterbed in Oudh. After 12 years, Chatter Sing returned home and died at Tharonto. His son, Pertab Sing, succeeded him and established a friendship with one Nahardil Nawab, who had founded Nahargarh. Umri was then in possession of the Thakurs called Tagurs; their chief was Pailad Sing, who ruled over 49 villages. Pertab Sing, in conjunction with Nahardil, took possession of this territory, gave his sister in marriage to the Kota Raja, Maharon Ram Sing, who was killed, at the battle of Dholepur, and appointed his own son Himmat Sing chief of Umri, who taking part in the above mentioned battle was severly wounded in it. When the Kota Raja was dying, he appointed Himmat Sing regent, as the heir Bhim Sing was only an infant. Himmat Sing in conducting the affairs of the child-king was obliged to take up his residence at Kotah which entailed on him the loss of three barais Mendpur, Badarwas and Nagdo. He had two brothers, Jaggat Sing and Jai Sing, with the Kheodaman as his umras, to him he gave for services rendered eight villages, of which five still belong to Kheoda and three are attached to Garha. He gave to Jaggat Sing with Bhadowra four villages and two others Mon and Bulapur from Tharonto. From the revenue of the former five Jaggat Sing had to render to him a tribute of 6 annas in the rupee: The latter were free. The three villages of Porsar, Mokhawan and Senera were conferred on Jai Sing who had also to pay the same tribute, with Senera free.

"At this time Saiman was Dewan of Sirsi, whilst Sosingji Khichi was chief of Rampura and had married the Umri chief's niece. These two were at variance with one another, but Saimon and Raja Himmat Sing were on most friendly terms. Sosingji told the Raja that if he would take his part and fight against Saimon he would give him 22 villages belonging to Rai, they coalesced and a battle was fought at Patai when Saimon Dhandera was beaten, and accordingly the Raja received the 22 villages of Rai. At Kadar Nath to which I have referred in the first part of this paper there were two pujaries or priests, both brothers; one lived at Bhadowra and the other at Umri and both divided the Pujari dues. The Raja of Ragogarh took possession of 15 villages of Rai and attached them to Bamori, thus only leaving in possession of Umri 7 villages which remained in the possession of the Umri Kings for six generations. In the fifth generation to Jagat Sing of Bhadowra, Man Sing was born and Ragogarh was attached to Gwalior. Man Sing enlisted John Baptist Filose on his side and induced him to secure to him in rental the above 15 villages. This was accordingly done, and it appears that in latter years Man Sing got the ear of some one in the pay of the English Government, and obtained thorough possession of those villages in addition to two others which he wrenched from the seven that belonged to Umri territory. This proceeding gave rise to a dispute on Agra. Man Sing died and Mohan Sing, the present Raja, was born and carried on the dispute for 30 years, and failing to consummate the ends he desired, he conferred with Mokam Sing the present chief of Umri and they divided the land of contention. However in 1862 Mohan Sing managed to secure the remaining five villages.

"This is the history of Umri up to its present date, and I have not the slighest doubt these two men will carry on their feud till they impoverish one another. Close on to Bhadowra directly above the banks of the Kunu, stands the hill of Sandor on which was once situated the strong-

hold of the same name. Below its base on all sides, covering an area of about 4 or 5 square miles, are the ruins of a very large and ancient city. It is traditioned that the Raja, who was then reigning, for some reasons deserted this site and established the stronghold of Rimtambour, which should properly be known as Ranth Bhounar. This Raja had made several attempts to establish himself in this locality, but was expelled each time till at last he was informed by a faithful retainer, whose name was Ranth, that unless he, together with his Doge, Bhounar, was decapitated, and their heads buried, the one under the right pillar and the other under the left pillar of the entrance gateway, and their trunks thrown into the fosse, the Raja could not obtain a firm footing. The sacrifice was made, and the retainer, a Seria by caste and race, nobly offered himself up a victim to the cupidity of the grasping chief, who of course now gained all he desired."

Extract from the Narrative Report of F. B. GIRDLESTONE, ESQ., *in charge of No. 2 Topographical Survey, Khandesh and Bombay Native States.*

Khandesh and portions of Holkar's and Scindia's territory, North and South of the Nerbudda River.

Remarks on the country triangulated.

The country triangulated this last season lay chiefly in the north-east corner of the British territory of Khandesh and Holkar's territory of Nimawur, lying to north-west of British Nimar in the Central Provinces. Small portions of the Native States of Burwani, Dhar and Scindia also came into the season's work. The southern half of the area triangulated, lying between Latitude $\frac{21° 10'}{21-30}$ and Longitude $\frac{74° 45'}{76-15}$, may be described as a perfect wilderness of hills, covered with high grass and dense jungle, embracing the main ranges of the Sautpoorahs, which stretch in one continuous chain from the craggy fortress of Assirghar on the east to the very lofty plateau of Turan Mal on the west. To the south these hills descend very abruptly into the plains of Khandesh, while to the north they fall by gradual long spurs, which again break into smaller ridges and then isolated hills down to the valley of the Nerbudda.

Hills.

The highest hill met with was the peak called Panchpandin in Latitude 21° 19′ 5″, Longitude 75° 40′ 34″, rising to a height of 3,522 feet above sea level, and about 2,595 feet above the large town of Yawal, lying in the plains of Khandesh immediately to its south. The ground between the southern ridge of the Sautpoorahs on which Panchpandin is situated, and their northern limit just before they commence to slope downwards into the low lands of the Nerbudda valley, is exceedingly broken up into ridges and plateaux, most of which average over 3,000 feet above sea level. These plateaux are often of considerable extent, such as that of Kotah, the centre of which lies in Latitude 21° 30′ 5″ and Longitude 75° 51′ 30″. They are beautifully wooded, chiefly with the Anjan, which much resembles an English birch tree, and whose light feathery foliage gives a park-like appearance to these undulating high lands.

The plateau of Kotah is singularly picturesque; from its eastern edges there are grand views of the wild broken country of the Pal Thuppa, the north east talooka of the Khandesh District, whilst on its western and southern sides the Anir and Kunda rivers offer much beautiful scenery, from the edges of the deep and well wooded gorges in which they run. Though destitute of inhabitants now, this and many other of the plateaux to be found among the Sautpoorahs abound in architectural remains of temples and other large buildings, leading one to suppose that these hills had once been thickly populated but forming now the abodes and haunts of wild animals only.

The climate of these plateaux was found to be delightful compared with that of the plains of either Khandesh or Holkar's territory, where hot winds commence to blow early in March. In the middle of May, my camp was pitched in the open on the Huri plateau 3,078 feet above sea level. The temperature was then 10° cooler in the day than on the low ground of Khargoon, lying on its northern side and 2,136 feet below it. At nights the difference was very much greater, and blankets were found very acceptable. The hot winds were blowing very fiercely down below, but on the plateau there was not a trace of a hot wind during the ten days my camp was pitched thereon. Huri plateau is well wooded and watered. It lies in Latitude 21° 32′ 27″ Longitude 75° 51′ 6″, is 32 miles from the nearest railway station of Raveee on the Great Indian Peninsula line, and is easily got at by the road leading from thence to the village of Pal, from which there is a good bunjari track right up to the top of the plateau. All these hills are said to be exceedingly malarious up to the middle of February. This year, however, owing perhaps to the great scarcity of water, my camp enjoyed fairly good health while among them. The natives, as a rule, much dread being taken into these hills apparently from fear of fever.

To the west of Huri the ground becomes wilder and the hills higher. The sacred hill of 'Tasdin' is a magnificent landmark for 30 miles round, and is a favourite spot for pilgrimages by Hindoos and Mahomedans. The summit is 3,389 feet above sea level. To its north in Latitude 21° 41′ 6″, Longitude 75° 23′ 32″, stands the hill fortress of Bijagar, now in a ruined state. It could be made very strong, as the hill is scarped on both the northern and southern sides. There are several tanks on the summit which is 2,708 feet above sea level. Between

Tasdin and Bijagar, and right along to the westward the country is very wild and jungly. The inhabitants are very few, and game, especially leopards, bison, and nilgai are very plentiful.

Rivers.

The Anir and the Kundi rivers were the only ones of any importance met with in the hilly portion of the work. Both these rivers rise near Lanka hill, the former flowing south-west till it finds an exit through the Sautpoorahs in a deep gorge underneath the hill called Sik, in plane table 29, from whence it flows in a southerly direction to the Taptee. The Kundi flows in a north-westerly direction towards the Nerbuddah, and takes the whole of the drainage from the northern side of the Huri and Kotah plateaux. The whole of the tract within the Sautpoorahs is, as a rule, badly off for water. A hill stream or spring was hardly ever met with, and my camp was often in very great difficulties. To many of the hills, on which observations were made, water had to be carried a distance of several miles. There was the greatest difficulty also in getting information from the Bheels about the spots where water lay, as they feared probably that their scanty supply would be speedily dried up if they allowed my large camp to make use of the pools from which they drew their stock.

Inhabitants.

Whilst the Southern portion of the season's work among the Sautpoorahs was found almost destitude of inhabitants, that to the north executed by Messrs. Belletty and Barkley along the Nerbuddah Valley was fairly well populated. Here and there among the Sautpoorahs are small clusters of temporary huts occupied by Bheels and Bunjaris, but even these run away generally on the approach of strangers. They make their living by cutting timber and selling it to the Bunjaris who come up from the plains, and eke this out by jungle fruits and fish from the Anir and Kundi rivers. They are wretchedly poor, very proud, lazy and fond of liquor, but an honest and humourous race. They seem to do very little in the way of cultivation, having no cattle, but are expert sportsmen with the bow and arrow. I found it difficult to induce them to do any work such as hill clearing, except when bribed with liquor or very high rates of wages.

Products.

The great trade of the country appeared to be in timber. The whole of the forests on the Khandesh side of the boundary are strictly preserved, but in Holkar's territory they are let out to contractors, and trees of all descriptions, young and old, are being taken away by the Bunjaris in immense quantities, and the forests rapidly sacrificed for present revenue. There are large stores of teak, damar, anjan and other valuable timber trees all over the Sautpoorahs, more especially on the northern plateaux, but instead of thinning and a judicious selection being practised, any trees likely to sell are allowed to be cut down.

Extract from the Narrative Report of COLONEL G. H. SAXTON, *in charge of No. 3 Topographical Survey, Central Provinces and Vizagapatam Agency.*

Bustar State of the Central Provinces, and Jeypur, Panchpenta, Madgul and Vizianagram of the Vizagapatam Agency in the Madras Presidency.

Triangulation and description of the country visited.

No new ground or extension of triangulation was required. The Deputy Superintendent went through the portions of country, where fewest points existed and closely interpolated over the current season's ground, and also where needed for next season. A chart of this work is being sent in, which with the original triangulation chart, as well as the standard maps, will shew that the ground surveyed, was closely filled with Trigonometrical points. Heights are given to nearely all of them; those without heights were laid down with a five-inch instrument, not suited for vertical observations.

The country passed through this season, includes some of the wildest and most difficult in this province; the elevations range from above five thousand feet, down to as many hundreds. Two considerable rivers, the Kolab and Sileru, run in a south-westerly direction towards the Godavery. In parts the country is almost impassable, and this difficulty in a measure hindered my attempts to combine inspection of surveyors with my triangulating duties. I came across the Great Trigonometrical Party and witnessed their very different mode of proceeding, a path being cleared from station to station, long before the large instrument and observer passed from one to the other. The large Galikonda range of hills, on which a sanitarium and coffee planting have been unsuccessfully attempted, and another almost equally high, (above 5,000 feet), Keverla range, are shewn in standard sheets Nos. IX and XXIV. There are villages and cultivated ground nearly up to 4,000 feet. Burji village Latitude 18°42'58" Longitude 82°56'56" where I was encamped is 4,015 feet, and has nice open cultivated and waste ground on all sides of it. The Galikonda range rises on north-east side of the village, and affords a plentiful supply of water. I shot snipe at this village in the month of March. On the more Western portion of the country under report, lies the Malkangiri plain, of very little elevation above the sea and regarding which a detailed report has recently been made to the Madras Government by the district officer, H. G. Turner, Esq., C. S. On the extreme west, beyond the Kolab river, the plain at same moderate elevation, extends in the Sunkom zemindary of the Bustar estate. This is a very wild and very sparsely populated country. Teak is met with throughout the portion surveyed by Mr. Adams on west side of the Kolab, but none to east of that river, at this portion of its course.

Geological notes on the country between Latitude $\frac{18° 15'}{18° 30'}$ *Longitude* $\frac{82° 30}{82 45'}$ *by*

Mr. JOHN HARPER *Surveyor, 3rd Grade.*

A Departmental Order by the Surveyor General of India, directing the attention of members of survey parties to the opportunities the nature of their field duties affords them, of throwing light on Geological, Archæological and other subjects of a kindred nature, emboldens me to offer the following remarks on the Geological structure of the portion of ground, which I surveyed in detail, during field season 1871-72, and I do so with the hope that this, my first attempt of the kind, may be treated with indulgence and taken for what it is worth.

"Page's Introductory Text Book on Geology" has been my principal instructor, and I have studied it during some of my leisure hours from beginning to end, availing myself of such opportunities of identifying rocks as presented themselves to me, and now quote such extracts from it as seem best to tally with the surface configuration of the ground under consideration. 'The old red sandstone' system seems to include every condition of this configuration, the first series of the second group more particularly which is summarised thus: 'course red conglomerates interrupted by beds of chocolate colored quartzose sandstone. Occasional fish scales and plants' and the following account of the physical features of the system, making allowance for some cases of disruption of trap rocks describes well the appearance of the country. 'The physical features of red sandstone districts in Great Britain are generally diversified and irregular; the hills being less bold and precipitous than those of primitive districts and more lofty and irregular than those of the later secondaries. Where the strata are unbroken by trap eruptions the scenery is rather flat and tame, but the soil is light and fertile, being based on sand gravel and friable clays, the ancient debris of the formation.

"On the other hand, the hills of old red districts present great diversity of scenery, here rising in rounded heights, there sinking in easy undulations, now swelling in sunny slopes and anon retiring in winding glens or rounded valley basins of great beauty and fertility. The igneous rocks connected with the system are varieties of trap. These traps are rarely interstratified with the sandstones and generally appear as disrupting and upheaving masses, either about the commencement or at the close of the period, when those hills and ranges were formed which confer on the old red districts their peculiarly undulating and diversified scenery. Looking at the whole system we are prominently reminded of marine conditions of sea shores whose sands formed sandstones, and of beaches whose gravel was consolidated into conglomerates and pudding stones. The reddish color which pervades the whole strata, shews that the waters of deposit must have been largely impregnated with iron, in all probability derived from the earlier granitic and metamorphic rocks whose degradation supplied the sands and gravels of the system.

"The scenery I am describing is considerably diversified, the hills varying from rounded heights to undulating ranges, and in some cases, hills with flat tops of considerable space, locally known as Bidings or Malies. On the two former the rocks are of sandstone with very few specimens of conglomerate among it, but on the Bidings I noticed that the sandstone prevailed for about two thirds of the height when it almost totally disappeared and the conglomerate took its place, generally enclosing the top with a precipitous wall and fragments being scattered all over it. These latter (Bidings) may be the result of an out crop of Trap Rocks and the conglomerate one of the rocks of that system, named trap-tuff, which is described as "occurring in every stage of texture from soft scoriaceous masses to compact aggregation, of rocky fragments cemented together by igneous action." The country is very pleasant to look on, is densely populated and extensively cultivated leading an eye witness to judge that it is very fertile. The presence of Trap Rocks may add to its fertility as well as to its beauty, as the following extract from the chapter devoted to them will shew. All the older secondary regions, that is, those occupied by the old red sandstone and carboniferous systems owe their surface configurations chiefly to manifestations of trap. Much of this is of contemporaneous origin with the rocks among which it occurs, and is of course interstratified with these deposits, but a great portion also is of posterior date, and in this case occurs as disrupting and overlaying masses. The scenery produced by assemblages of trap hills is often extremely picturesque and beautiful, and the soil produced by the decomposition is generally so dry and productive, that the term trap district is usually regarded as synonymous with amenity and fertility.

"The River Machkund of last year, in my ground known as Machieru (fish river) runs a very tortuous course about diagonally across my board, and after its junction with a tributary 'the Patal,' equally tortuous, becomes very deep, and fords only occur at considerable intervals. The beds of minor water courses are invariably covered with fragments of sandstone of sizes, all shewing a tendency to rectangular form."

Note by MR. J. A. MAY *Surveyor, 4th Grade on the country surveyed by him during field season* 1871-72.

Latitude 18°15' to 18°30'.
Longitude 82°15' to 82°30'.

The ground I was engaged on during the past season was of a very difficult nature, consisting of the out-fall of the Jeypore plateau to the south-west. High ranges of sandstone formation running parallel to one another, end in small confused hills

of the same formation, intersected by numerous large streams, which form many waterfalls at their descent from the table land, and run through deep rugged ravines. Of these the Boro-Kolab (great valley) river is the principal, being the same with the Machkund as given in the maps submitted last year.

To the south-east corner, and extending into my neighbour Mr. Harper's ground, are numerous flat topped hills, the out cropping rocks of which are a species of conglomerate, composed of sandstone and other rocks of a rusty color, cemented together with some substance resembling lava; their tops are bare, and the slopes, for the most part, covered with forest. The most remarkable hill in my ground is Cherubiding H. S. one of Colonel Saxton's stations, and has been described by him, but an account of which, I trust, will not be out of place here. This hill is about a square mile in extent, having two principal undulations, on which the stations are, and between them is a curious looking depression suggesting the idea of an extinct crater about 150 yards in length, being nearly in form of a square, with banks fifteen feet or thereabouts in height, in which, during the rains, water is retained to a depth of from four to five feet. There are two outlets to this little basin opposite to each other, forming rather considerable streams, which meet about four miles distant in the valley below.

A legend is current among the natives as to the origin of this hollow, and is as follows:—At a time, as is generally the case with such stories, beyond the memory of man, one of their gods, named Bhima, with his sister occupied this hill and jointly cultivated it; and as it was usual for them to labor apart in a state of nudity, Bhima, to prevent unseemly rencounters, had recourse to a string of bells which he wore round his waist, and served to make known his approach to his sister who immediately covered herself in order to receive him. But on one occasion she accidentally appeared before him naked, a circumstance which so shocked their modesty, that they fled precipitately from each other in opposite directions—thus the basin is said to have been formed by rice cultivation, and the two outlets of the respective paths taken by this highly modest couple. The presence of 'Paddy' unaccountable to the villagers has no doubt led them to the framing of this legend. I was encamped on Cherubiding for a day in the month of March, and found it delightfully cool and pleasant. A little way down the hill, in one of the streams above alluded to, is a spring of good water which I believe is perennial, as is the case with all streams on the highlands.

The Boro kolab or Machkund runs diagonally across the ground in a south-westerly direction parallel to the ranges of hills on either side in a deep narrow valley. It is fordable near the villages Sindgur, Bojugura and Amliwara during the dry season, but farther down it is very deep, and alligators are said to be plentiful. In these parts, the only means for crossing the river are small canoes scooped out of solid logs of sall *(Shoria Robusta)* about 15 to 20 feet long and 2 deep; these are at best unsafe, but by lashing two together, a boat, reliable and capable of bearing a pretty heavy load, is constructed, but the scarcity of canoes makes it a matter of the utmost difficulty to cross a camp. It is remarkable that this river seems to separate the Telegu from the Ooria speaking people, the former occupying the country on its left bank. Another peculiarity I noticed was that on its right bank the magnetic needle was deflected to a great extent and unequally by the iron stone so plentiful in the little hills about, and caused me great annoyance and extra labor while surveying, as I could not depend on a station unless made by reference to three or four points. On the opposite bank, however, the needle seldom or never varied.

The general aspect of the country is hilly, rugged and forest-clad, and, excepting on the highlands, cultivation of any kind is rarely to be seen. The villages in the valley are very few, scattered and small, seldom consisting of more than two or three huts, and inhabited by wretched specimens of humanity who are, for the most part, afflicted with loathsome scrofulous sores, which render them almost useless to themselves and to others.

Roads, which are nothing better than mere paths leading from one village to another, are few, and, with the exception of one or two, bad in the extreme, running as they do along steep ravines and over rocky ghâts quite impracticable to beasts of burden.

The several tribes inhabiting this portion of country are the Bhoudas, Dera Porja, and a caste of people who speak the Telegu language exclusively. Of these, the Bhondas are the most remarkable, the rest being in general like the other tribes to be found in Jeypur and the adjacent districts.

The marriage ceremony costume of the women and religious observances of the Bhondas are peculiar to themselves. These people, who are to be met with chiefly on the highland between Andrahal and Dangapara in the district of Jeypur, and comparatively few in number, keep themselves apart from all other tribes with whom they do not intermarry. The men are not bad looking, they are well built and active, and passionately fond of sport, of which they seem to be very jealous with regard to Europeans; they dress like the other Ooria tribes, and adorn their necks with beads, but to a moderate degree.

The women, however, are extremely ugly, both in features and form, which is rendered more repugnant by their short hair, and the scantiness of their attire which consists of just a piece of cloth, either made of the kerong bark and manufactured by themselves or purchased from the weavers of the country, about a foot square, and only sufficient to cover a part of one

hip; it is attached to their waists by a string on which it runs, and can be shifted round to any side. A most ludicrous sight has often been presented to me by a stampede among a number of these women, when I have happened to enter a village unexpectedly where they had been collected in the centre space usual in their villages intent upon their occupations. On my approach, each one and all hurried to their respective dwellings, and, as they ran in all directions, endeavoured to shift this rag round to the part most likely to be exposed to me. They are necessarily very shy, and are seldom to be met with out of the village, except at mid-day, when engaged assisting the men in the preparation of ground for cultivation and when there is the least possible chance of meeting with strangers; but among themselves they do not seem to be at all particular.

This peculiar mode of dress originated in the following legend, implicitly believed by the Bhondas:—'Time out of mind, the Goddess Sita happened to travel through this part of the country, and when she halted on one occasion while superintending the preperation of her mid-day repast, found herself surrounded by a large number of naked women; she blushed to behold such indecency, and forthwith presented them with a piece of tussur cloth, which was eagerly accepted, but when divided, found to supply each one with only just enough to cover one hip. The Goddess, whose travelling wardrobe evidently did not allow of greater liberality, then commanded that they should always in future cover themselves thus much, death being the penalty of their disobedience; my informant gave me to understand that one of the Government agents in these parts, some years ago, insisted on a young woman being properly clothed, the result was she survived the change only three days'! This story, which is declared to be strictly true, has unfortunately had the ill effect of confirming these people in their superstition.

Their marriages are consummated in a very curious manner. A number of youths, candidates for matrimony, start off to a village, where they hope to find a corresponding number of young women, and make known their wishes to the elders, who receive them with all due ceremony. The juice of the Sallop (sago palm) in a fermented state is of course in great requisition, as nothing can be done without the exhilerating effects of this their favourite beverage. They then proceed to excavate an under-ground chamber (if one is not already prepared), having an apperture at the top, admitting of the entrance of one at a time; into this the young gentlemen, with a corresponding number of young girls, are introduced, when they grope about and make their selection, after which they ascend out of it, each holding the young lady of his choice by the forefinger of one of her hands. Bracelets are now put on her arms by the elders (this has the same signification as the wedding ring among European nations), and two of the young men stand as sponsors for each bridegroom. The couples are then led to their respective parents, who approve and give their consent. After another application of Sallop, and sundry greetings, the bridegroom is permitted to take his bride home, where she lives with him for a week, and then, returning to her parents, is not allowed to see her husband for a period of one year, at the expiration of which she is finally made over to him.

Their religious ceremonies, like that of their neighbours, consist in offerings to some nameless deity, or to the memory of deceased relations. At each of the principal villages the Bhondas congregate once a year in some spot conveniently situated for their orgies, when a chicken, a few eggs and a pig or goat are offered, after which they retire to their houses, and next day assemble again when the Sallop juice is freely imbibed, till its intoxicating effects have thoroughly roused their pugnacity; the process of cudgelling one another with the branches of the Sallop now begins, which they apply indiscriminately without the smallest regard for each others feelings; this, with the attendant drum and shrieks, would give one the impression of a host of maniacs suddenly set at liberty. This amusement is continued till bruises, contusions and bleeding heads and backs have reduced them to a comparatively sober state, and I imagine, old scores paid off, when they return to their several houses. Thus ends the grand festival of the year. Their other festivals have nothing remarkable.

Country produce is poor and limited to Sua (a small grain resembling sago) and Khandol a large species of arrar dâll, which are cultivated on the slopes of hills; rice is also grown in the beds of small streams which are terraced and bunded for the purpose, but to a very small extent, Sua being the staple. This grain is prepared for food by either boiling to the consistency of gruel or hard-like rice.

The natural products are iron ore, gall nut, and stick lac. This last is to be found only on the Kussum tree (the hardest of all jungle wood), on the twigs of which the little lac insects build their gum-like nests which constitute the lac. These are collected by the villagers in small quantities, and sold or bartered for at the different hauts or fairs about the country.

The only timber trees I could recognise were the sall, a few wretched specimens of teak on the banks of the Boro kolab, and kendu, a species of ebony.

Game is plentiful, as must be the case, in a country so thinly populated. The Bison (gaor) sambur, pig, axis or spotted deer, the ravine deer, bears, and occasionally the wild buffalo and tigers, roam at large and fearless of man, with whom they are so little acquainted. Pea fowl and other wild fowls are abundant. The otter also is to be found, but only on the banks of the larger streams.

Extract from the Narrative Report of MAJOR G. C. DEPREE, *in charge No. 4, Topographical Survey, North-Eastern Division, Central Provinces.*

SOHAGPUR OR REWAH STATE AND BELASPUR DISTRICT.
Country Topographically Surveyed.
Latitude 22° 30' to 23° 30.'
Longitude 81-30 to 82-15.

The country surveyed in detail during the last season may be briefly described in three sections.

First or highest level.

First is the high plateau, called the Mekal-pât by the country people round about, from which rises at Amarkantak the Nerbudda river flowing westwards and falling into the Gulf of Cambay. Within two miles of the same spot, and from the same hill, rises the Johilla, which, flowing north-west, joins the Soan and flows into the Bay of Bengal. The highest part of the plateau is 3,860 feet above sea level, and the valley of the river Nerbudda is in this part 2,600 feet, and that of Johilla 3,000 feet above the sea. The northern face of the plateau descends very abruptly to the plain of Sohagpur. This face has been surveyed for about 50 miles only. The valleys of this plateau are perfectly bare of forest, and are covered with tall coarse grass. They are thinly inhabited by wild Gonds, who live in wretched mud huts. The Gonds are bad cultivators; they plough and sow the ground for three years, and desert it for other virgin soil. The country of rice cultivation and terraced fields, as found in Chota Nagpore, is no more met with, and the crops consist of kodo, wheat, gram and other grains, which grow on uplands with a small expenditure of labor. The chains of hills, separating the valleys and the summits of the various plateaux, are covered with heavy jungle.

Second level.

The second is the terreplein of Pendra of Chateesgurh and Sohagpur of Rewah. On the south part of this rises the Soan river at an elevation of 2,100 feet above the sea. It flows north and north-west through an undulating country, fairly inhabited and cultivated by a Hindoo population. The country below the fall of Mekal-pat is 1,600 feet.

Third level.

The third level is that on the south of the plateau on which is the source of the Soan. It forms part of the estate of Kenda of Chateesgur. All the streams of this tract fall into the Mahanadi river, which reaches the sea on the east of Cuttack. The elevation of Kenda is 1,150 feet. The hills and valleys are thinly inhabited by a mixed Hindoo and aboriginal population, and the jungle is very dense.

Extract from the Narrative Report of CAPTAIN R. V. RIDDELL, R. E., *in charge No. 5 Topographical Survey, Bhopal and Malwa.*

EASTERN PORTION OF BHOPAL PLANE TABLED.
Latitude 22° 45' to 24°.
Longitude 78° to 78°-50'.

"The country plane tabled was chiefly in a fairly well cultivated tract, that is, villages were numerous, and the population in proportion, and the soil that was under cultivation was rich and easily manipulated. During the season under report, 2172·26 square miles of the Bhopal State were surveyed, of which 1,361 square miles were cultivated; 590·3 square miles of the Gwalior State, of which 419·1 were cultivated; 30·4 square miles of the principality of "Mohamedgarh", of which 13·3 were cultivated; 39·75 of the principality of "Nawáb Basoda," of which 23·1 were cultivated; 16·31 of the principality of "Pathári," of which 11·6 were cultivated; 32·4 of the principality of "Kurwai", of which 22·2 were cultivated; which shews a general proportion of land cultivated at 60 per cent. of the whole.

The three principalities of "Mohamedgarh," "Nawáb Basoda" and "Pathári," will not again be met with in the course of the work of this party, and I believe the whole of their territories were surveyed this last season by this party. The principality of "Kurwai" will again appear, but in very limited extent part of it must have fallen to the lot of No. 1 Party. The soil is almost entirely of the description commonly called (I believe) the black cotton soil. During the rains this becomes so soft that the flat parts of the country resemble a quagmire; every thing seems to grow very quickly; hills that I had cleared the previous year for observing for triangulation were covered with bush jungle about 15 feet high.

Hills.

Diagonally, through this season's work, a little south of the centre ran the back-bone of the "Vindya" range; the general level of its crest is about 1,800 feet above the sea level, but there are several peaks and ridges, dotted about the main ridge, which rise to nearly 2,400 feet. I am not quite sure where the main ridge of the "Vindya" range enters this survey, but I think that it lies between the "Dassán" and the Beas, and is defined by the water-shed between those two rivers as far as the hill called Jasarti H. S. If so, the hill north of the village of "Udka," 2,186 feet above the sea level in plane table, section 4, is the first peak commencing from the east, on the water-shed of the "Vindya" range. Then the hill called "Jasarti" H. S., 2,347 feet above the sea level, at the foot of which springs the "Dassan," is the next prominent point on the ridge, then a little peak on the ridge south of the village of "Bichna" in plane table No. 8, then the peak called by us "Dabri" H. S. height 2,365 feet above the sea level, between the villages "Pipalia", "Dabri" and "Nagpura."

The next prominent hill on this water-shed is "Baorgarh" H. S., height 2,056 feet, touching the village of "Baorgarh" in plane table No. 9; between "Dabri" and "Baorgarh" there is a prominent hill, height 2,121 feet north of the village of "Sodarpur," but this is about 1½ miles north of the main water-shed.

West of "Baorgarh" the next prominent feature on the ridge is the "Bilwani" hill, height 2,001 feet above the sea level; following the course of this ridge westwards the track lies over the low hills near the village of "Indiari" and "Mulameta" in plane table, section No. 10 to the village of "Jhamar," and thence to the summit of the "Rajghat" pass. This pass is the high road between Bhopal and the south-eastern mehals or pergunnahs of the Bhopal State; at this point a prominent water-shed springs into existence, *viz.*, the one between the "Bina" and the "Betwa," and this runs out from the "Vindya" range in a northerly direction; on the eastern side lies the "Bina" and its feeders, which run at a considerably higher level than those of the "Betwa" on the west side. At this latter side there is an abrupt fall of about 400 feet, and then a large plain drained by streams which run into the "Betwa" at a level of from 1,500 feet near the foot, the abrupt fall just mentioned, to 1,400 feet at a distance of 30 miles from the "Rajghati" pass; whereas on the eastern side the fall is at first very gradual up to a distance of 30 miles from the same pass; the plateaux between the streams are at a height of 1,800 feet, and the streams themselves are not less than 1,600 feet above the sea level. From the "Rajghati" pass westwards the water-shed of the Vindya range follows a much less well marked course, at a level in some places as low as 1,600 feet to "Narwar" H. S., height 1,937 feet above sea level.

The highest hill on this range, or in the ground as yet met with in this survey, is "Kheda" H.S., height 2,385 feet above sea level on a spur of the "Vindya" range, running eastwards from "Dabri" H. S. South of the water-shed between "Kheda" H. S. and the "Rajghati" pass there is an abrupt fall of about 750 feet below the general level of the water shed, south of which is a richly cultivated plain, 10 miles wide at its greatest width, extending about 32 miles from west to east. This valley is encircled by spurs of the "Vindya" range, roughly resembling a distorted horse-shoe, one side of which springs from west of the "Rajghati" pass, and the other from "Kheda" H. S. Joining the heels of this horse-shoe is a bar of low hills, between which there are several passes. The main water-shed of the eastern spur takes the following course from "Kheda" southwards over the hill west of the village of "Ghana" to "Surkari", then eastwards and a little north-east as far as the meridian of 78° 40′; then down the spur on which the boundary between the Bhopal Territory and the "Saugor" District to a point called in our triangulation "Gogri" north pole (height 2,120), at a little west of which the water-shed is at a low level, and crossed by a road running northwards from "Gogri." From "Gogri" north pole the water-shed runs to "Narainpur" peak, then southwards through low ground past the villages of "Papro" and "Salabaru" across the hill on which the village of "Chargama" is situated to a hill about 1½ miles west of the point called "Katak" H. S. (height 1,530) in our triangulation, then westwards towards the peak called in our triangulation "Sara," east pole; along part of the ridge between "Sara," east pole, and the village of "Jujarpura," to south of the village of "Bana Deari," then up to the hill known as "Dudia" (height 1,987) on which our principal station of that name is situated, and from thence westwards to the foot of the hill near the village of Patna.

This line, as far as "Sara," east peak, is the water-shed between the "Sendur," on the east (which, for a long distance forms the boundary between the Bhopal territory and the British districts of "Saugor" and "Nursingarh") and the "Tendoni" on the west. The western side of the valley is bounded by a ridge running southwards from "Rajghati," on which "Singori" H. S. (height 2,148) and "Kartoli hill" pole (height 1,854) are situated, then nearly southwards as far as the parallel of 78° 15′ to about two miles north of the village of "Udejri". Between this point and "Dudia" H. S. is a ridge of hills on which "Badalgarh" H. S. (height 1,792), "Dongeria" H. S. (height 1,532), "Piperia" pole (height 1,378), "Singota" pole (height 1,273), "Kissenpur" H. S. (height 1,435), are situated. The hills forming this belt are almost all abrupt and precipitous on the south face, but comparatively of a gentle slope towards the north. The belt is cut through by numerous streams, generally running southwards, but here and there, as if on purpose to break the monotony, the sources of the streams running between these hills are in the plain south of the belt of hills.

From about the meridian of 78° 7′ another spur leaves the main ridge of the "Vindya" range, but this spur is so broken that it represents the appearance of isolated groups of hills, which terminate near the village of "Bari." These hills present features of every possible shape and shape, but throughout the southern portion the abrupt precipitous slope is facing the south, and the gentle slope faces the north; the most remarkable of these hills are the groups between the old fort of "Chokigarh" and "Badalgarh," which, from the north-east or from "Dudia" H. S., present the appearance somewhat like a saw, the difference being that the heights of the peaks of these hills are not so regular as the teeth of a saw.

A little west of the group of hills south of "Chokigarh," is a gorge, through which issues a river which collects the drainage of a circle of about 15 miles in diameter, although from either side a spectator might imagine, from the rocky and precipitous appearance of the hills, that a road to the other side would be impossible; yet there are two very fair roads on the right bank of the "Bamne," which join near the village of "Furtalla," and are extensively

used by the "Binjaras," are passable for carts and camels. On the left bank of the "Bamne" there is also a road which could very easily be made passable for carts and camels.

On the water-shed between the "Betwa" and the "Bina," starting from the "Rajghati" pass, the hills called "Bilgarh" (height 2,221), "Saugor" H. S. (height 1,956), "Lakoli" H. S. (height 2,184) in sheet No. 5, standard map "Mankapur," east tree (height 2,022), "hill pole" 15 (height 1,981), hill pole 24 (height 1,930), "Chiroda pole" (height 1,893) in sheet No. 3 of the standard map are situated. North of the last mentioned sheet the ridge takes the shape of isolated hills, of which there are several very conspicuous ones in sheet No. 1 of the standard maps, more especially the hills on which the stations of "Pathari" (height 1,885), "Teonda" (height 1,866), and "Udepur" (height 1,878), are situated, also the peaks called on the chart of triangulation, "hill pole 1" (height 1,715) "Belai pole" (height 1,871), "hill pole 3" (height 1,762), "Saiba tree" (height 1,838), and "hill pole 23" (height 1,867); these peaks rise up to 500 feet or nearly so above the surrounding plain.

Rivers.

The principal rivers met with in the season's work are the "Narbadda" with its feeders the "Sindor," the "Tendoni," the "Banna."

The "Betwa," the "Bina," with its tributaries, the "Dudai," the "Semri," and the "Babnai." The sources and small portions of the "Dassan" and the "Beas," both of which were large rivers in the Bundelcund States, formerly the field of survey of this party.

The "Narbadda."

The "Narbadda", where it enters the work of this party in standard sheet 6, is a river of a little more than 300 yards in width from bank to bank, running between steep banks, some 40 or 50 feet in height, between the "Sindor" and the "Narbadda," and about 1¼ miles from their junction, the level of the ground is 1,091 feet above sea level, at the station called "Hirapur," which was made in a field. At 63 miles further along its course where the "Narbadda" crosses the meridian of 78°, it is over 900 yards in width from bank to bank, and the general level of the country on either side at a distance of about a mile from its banks is 1028 feet, which would shew that the river had a fall of 63 feet in 63 miles, or an average of a foot a mile. There are numerous fords and ferries across this river, which are detailed in a separate form appended to this report.

The "Sindor."

The "Sindor," where it joins the "Narbadda," is a stream of about 100 yards in width; it rises in standard sheet No. IV in Latitude 23°-22′ Longitude 78°-40′, about 4 miles from "Kheda" H. S., and about a mile from a peak called in the triangulation "Berkheri" West peak. The course of the "Sindor" is about 40 miles in length, starting in a south easterly direction, and gradually turning towards the south.

The "Tendone."

The "Tendone" rises about 4½ miles south of the source of the "Sindor," starts in a south easterly direction, but turns round to the south west after it has run about 8 miles, continues more or less in that direction until it joins the "Narbadda" near the village of "Bagalwara," in sheet No. IX Longitude nearly 78°-15′: its entire length is about 70 miles, and its chief tributaries are the "Nahania," length 17 miles springing from nearly south of "Sirmow" in standard sheet No. IV.

The "Nakte," length 27 miles, springing a little west of the village of "Dabri" in standard sheet No. IV. The Bhurka, length 13 miles, springing about 2 miles south of "Jeithari" in standard sheet No. VI. The "Gajanda," length 20 miles, springing from near "Bilwani" hill near the middle of standard sheet No. V. The "Garanj," length 27 miles, springing from near the village of "Jhamar" west of the above, and in the same standard sheet.

The "Banne or Bamne."

The source of the "Banne" is somewhere near "Kaliakeri" in degree sheet No. III which will come into the field work of the coming cold weather, but the last 33 miles of its course lie in the country already surveyed. The "Banne" passes through the south west corner of standard sheet No. VII when it is joined by the "Chamarsel," a stream of about 15 miles in length springing near "Narwar," in standard sheet No. V; the "Jamner" which rises in degree sheet No. III and the "Narhari," a small stream of about 14 miles in length rising near the north of standard sheet No. VII. In sheet No. IX the "Jamner" is joined by the "Ghogra," a stream of about 25 miles, rising south of "Rajghati" in standard sheet No. V; finally the "Banne" joins the "Narbadda" west of "Bagalwar" at a distance of 1½ miles from the junction of the "Tendone" with the "Narbadda."

The "Beos."

The "Beos" rises at "Sirmow" standard sheet No. IV, and before it passes out the Bhopal Territory into the "Saugor" district near "Patha" in standard sheet No. II, it becomes a sluggish stream running between steep banks of a soft clay from 50 to 100 yards apart, in the last 6 miles of its course through standard sheet No. IV, and in this distance only three fords are met with.

The "Dassan" rises at the northern side of the hill called "Jasarte" H. S. in our triangulation, close to the village of the same name in standard sheet No. IV. The first 14 or 15 miles of this river come into this season's work standard sheet No. II; and in this distance there are numbers of fords. Where the "Dassan" leaves the Bhopal Territory; it is a stream about 80 yards in width.

The "Dassan."

The "Bina" rises near "Bilgarh" hill, Latitude 23°-19'-4" Longitude 78°-10'-42", south of the village of "Lutri;" in standard map No. V, after having run a course of about 35 miles; in a direction a little east of north, it is joined by a stream of about its own size formed by the junction; a mile further east of the "Semri," and the "Dudai" which take their sources near "Sodarpur" and "Dabri" respectively in sheets No. V and IV. Seven miles further on, the "Bina" leaves the field of survey of this party, and passing through a corner of the Saugor district is again met with in Latitude 23°-55' Longitude 78°-20' sheet No. I, where it is is joined by the "Babnei," and becomes the western boundary of the Saugar district. From this point the "Bina" is a river of formidable dimensions, its banks being from 200 to 300 yards apart. There are numerous fords and ferries across this river which are all detailed in a separate form.

The "Bina."

Only a small portion of the "Betwa" has fallen into the ground surveyed this season, *viz.*, 7 miles in the north-west corner of standard map No. I. It is here a river of from 200 to 300 yards in width; about a mile east of where the "Betwa" leaves the work of this party, another stream, the "Keotan," also passes into the work of the Gwalior party, and must very soon afterwards join the "Betwa." The "Keotan" takes its rise about 4½ miles south of "Garaspur" in sheet No. III and runs about 36 miles before it passes into the work of No. 1 party, drawing all the drainage of about 270 square miles of country, chiefly to the east of its course. One of the tributaries of the "Betwa" the "Neon" by name rises near "Rajghati" in sheet V, but passes out of the work surveyed at about 12 miles from its source.

The "Betwa."

The "Keotan."

The population is chiefly Hindu, the proportion as yet met with shows 15 Hindus to about 1 Mussulman, and these latter are seldom to be found except in the large villages and cities. At the eastern end of the valley of the "Tendoni," there are several "Jagirdars" descendants of the old Gond proprietors of the soil; their jaghirs do not seem to have a large proportion of the rich soil, but perhaps they and their ancestors have not been so industrious as the more pushing followers of the reigning creed.

The heat in the "Narbadda" valley and in the valleys south of the crest of the "Vindya" range is far greater than anything I ever experienced in Rewah, Bundelcund, Gwalior or Jeypur. In those districts I never remember registering a greater measure of heat than 102 Fahrenheit at the hottest time of the day, in a small hill tent, up to the end of the third week in April. But during the last two years south of the crest of the "Vindya" range I have registered 105° to 107° in a large and better tent, every day after the middle of March and sometimes in April as much as 109°. The Klassies who are chiefly inhabitants of Oudh show that they feel the difference of climate as much as we do."

Memo. of Forts and petty "Garhis."

Chokigarh Fort in standard sheet No. VII is situated on the northern end of a spur (600 feet above the plain) of the group of hills north of the town of "Bári." These two places are said to have been the chief residencies of a Gond Rajá who possessed this portion of the Bhopal territory, and built the fort some 200 years ago.

"Chokigarh" Fort

The fort is in shape, roughly speaking, that of a rhombus, the sides of which are about 600 yards in length, and whose corners point nearly to the north, east, south and west respectively, but as the wall follows the shape of the rock on which it is built, a cross fire could be brought to bear on several parts of the approaches in the immediate vicinity of the upper wall.

There are five gateways in the upper wall, one near the eastern corner, is called the Bhopal gate, and is the chief entrance to the fort; the road to this gate from the village of "Alampur" is such that carriages may be driven up to the outer gate, which is about half way up the ascent.

At the northern gateway the descent to the village of "Karanpur" is merely a foot-path, now used by the sepoys (whose wives and families all live at "Karanpur") on their way to and from their food.

At the eastern gateway the approach is passable to horses, but this is not used now.

The southern gateway is not used now, there is a ditch outside this portion of the rampart wall, which is here higher, thicker and more solid than at any other part. This leads out into a plateau on about the same level as the fort, and extending in a south-easterly

direction for nearly a mile, having an average width of about 300 yards, along which there is a foot-path past the point called "Nagpani hill pole" to "Bári". The fifth gateway lies between the southern and western ones, and is now seldom used."

The rampart wall varies in height; in some places when a natural wall is formed by the abrupt drop of the side of the rock, it is only 2 or 4 feet high, formed of stone without mortar, at others, especially at the southern corner, it is about 20 feet in height, built of squared blocks of stone averaging 27 by 18 by 9 inches in measurement, well and firmly set together.

The Bhopal gateway is the one on which the greatest amount of labor seems to have been bestowed; at this entrance there are three gates to be passed before an entrance to the top of the plateau or interior of the fort can be effected.

The remains of the old Raja's dwelling house are still standing, but in ruins. There is a tank among these ruins connected with what seems to be a deep well cut out of the solid rock, but the natives say that the water is all from the clouds; no spring exists. Lower down near the outer gate of the Bhopal entrance, there is a large tank which seemed full of water at the end of the month of March.

In ancient days this old fort might have been a formidable stronghold, but must have been useless as anything else, for it commands no great roads or important passes.

"Mahilpur Fort."

There is a small fort which though built of masonry can only be called a petty "Garhi" at "Mahilpur" in the "Raisin" pergunnah. Its shape is simple, being either a square or rectangle whose sides are about 120 yards in length, and at the corners of which are four circular towers; the walls are about 20 feet high, and two feet thick at the top.

"Garhi Fort."

At "Garhi" "Amapani" there is a small fort of the same character as the above, now merely used as a tehsil building. This was built by the late husband of the present Begum, and used to be of larger dimensions, and covered ground measuring 300 and 250 yards. Report says that during the mutiny the tehsildar mutinied, he burnt the village of "Garhi" and occupied the fort, but having been driven out by some British troops, he fled to "Ratgarh" where he was caught and hanged. After this the greater portion of the walls were knocked down. The above two are both in standard sheet No. V.

"Siwas Fort."

At Siwas, standard sheet No. III, there are the remains of an old fort of an irregular description in the centre of the village. This might be more formidable, if it were not for a hill on the south-east side of the village not more than three-fourths of a mile distant, from which the fort could be made untenable.

"Deori Fort."

Near the tehsil of "Deori," at the once eastern end of Bhopal, a thick wall enclosing a portion of the hills north of the village and extending for some distance eastwards along the crest of the ridge, is supposed to be the remains of an old fort or fortified camp built by the Gonds.

"Mohamedgarh Fort."

At "Mohomedgarh," standard map No. III, there is a small hill fort, a petty "Garhi" built of solid masonry situated at the northern end of the hill, at the foot of which is the village of "Mohamedgarh" overlooked by the fort. This fort is in shape a rectangle whose sides are about 200 yards and 150 yards, with circular towers at the corners. The hill on which this fort is built is said by the assistant who surveyed it to be inaccessible except from two points, one from the village of "Mohamedgarh" from which a foot-path ascends to a point a little south of the fort, and the other from the village of "Chichli;" this seems to have been the principal entrance. This is the residence of the Nawab of the principality of the same name, which is a feudatory of the British Government, but the principality is guaranteed to the Nawab by the British Government.

"Nawab Basoda Fort."

At "Nawab Basoda," 3 miles south-east of the above, there is a similar little fort, but larger and having an outer wall built on the east end of the hill, at the foot of which lies the village of "Nawab Basoda" also overlooked by the fort. The hill on which the fort is built is accessible to men on almost all sides, carts can ascend from the village of "Barwai." The Nawab of this principality acknowledges Gwalior as his Suzerain, but his principality is guaranteed to him and protected by the British Government.

Extract from the Narrative Report of CAPTAIN GEORGE STRAHAN, R. E., *in charge, No. 7 Topographical Survey, Rajputana.*

Odeypur, Jodhpur and Mairwarra.

The country over which my triangulation extends this season is on the eastern flank of the Arabulla range, the height of which appears to have attained its maximum about here, according to Mr. Horst's report, extracts from which are given below. Its breadth is about 20 miles.

There is a difference of 800 or 900 feet between the level of the plains on the eastern and western flanks, the latter being the lower. The forms and general appearance of these mountains differ greatly on the two sides. On the eastern or Meywar side the plain rises gradually, and becomes more and more broken up with little irregular hillocks of rock until a plateau is reached, from which the highest summits rise in long ridges nearly precipitous on both sides. In many parts there are two or three of such ridges running closely parallel to each other, and forming valleys which are entirely inaccessible to wheel conveyances or laden camels.

On the Marwar side the descent is abrupt, the features of the hills larger and the jungle thicker. The mountain outlines are more imposing, but their color is too monotonous to produce really beautiful effects. This chain forms one of the most important watersheds in India, the drainage on the western side converges for the most part to form the Luni river, and on the eastern the Banás, the former flows into the Runn of Cutch, and the latter into the Chambal and thence to the Bay of Bengal. I have not yet heard that any minerals of interest or importance are found in this range, but during the approaching season more information will be obtained as the detail survey is then to be taken in hand. These hills are but thinly populated; the inhabitants are almost entirely Bheels.

The main road from Nimuch to Mount Ábu *viá* Erinpura runs through the chain on the parallel of 25°-16' in a gorge called the Desúri Pass. The road is very picturesque, bordered on both sides by cliffs nearly 1,000 feet high, between which glimpses of the far off plains of Jodhpur are obtained from the crest of the pass. Its length is about 19 miles, the road is quite practicable for carts, though the gradients are steep in places especially on the Marwar side. There are chokies at every two or three miles, but nevertheless highway robberies are not unfrequent."

Extract from report by H. Horst, Esq., *Assistant Superintendent.*

"The Arabulla Range runs along the eastern edge of the country triangulated, and so far as I know attains its greatest altitude here, next to Mount Abu which, however, can scarcely be considered as belonging to the range. The highest point Jargo is found to be 4,330 above the sea. It is about 28 miles north-north-west of Odeypur and 3 miles south-west of Kelwara. The range is visible for 80 or 100 miles onward from here, but there is apparently no other summit of equal altitude with this. Its form is similar to that of the other commanding summits of this chain, *viz.*, a long precipitous ridge rising abruptly from a plateau constituting the watershed of this part of India. The western portion of the country triangulated is in the plains of Marwar. These plains are dotted with small rocky hills appearing at long intervals, and varying in height from 600 to 2,000 feet above their bases.

"The cantonment of Erinpura is situated on the boundary between Marwar and Sirrohi, on the left bank of the Joni River, as a post of observation where the regiment called the Erinpura Irregular Force (formerly the Jodhpur legion) is located. Major Carnell commands this regiment and is also invested with political powers. He has done much towards suppressing the Bheels and Minas in Sirrohi and Marwar who are often taken red-handed in dacoity and murder. When I was working a few miles from Erinpura, a dacoity was committed on a caravan attended with bloodshed almost on the very spot on which two criminals were executed three days before, and hung up on the branch of a tree.

"While encamped at Sodabass, a large village in the Jodhpur district, a raid was about to be made by a large gang of robbers, but on seeing my camp they made off. The villagers assured me they had been frequently plundered, and most certainly would have been on this occasion but for the presence of my camp.

"I came across a very curious old temple in a gorge about 8 miles south of Ganerao built in the form of a cross. The length is about 100 feet. The central part where the arms of the cross meet is covered in by a circular dome in which are recesses for idols. The arms themselves consist merely of enclosures formed by stone pillars surmounted by a row of small domes, so that the whole building has the appearance of a group of temples. I have preserved a tracing of an inscription on one of the stones, but have not succeeded in finding any one who can decipher it. There are some traces of a ruined village called Ranpur adjoining."

REPORT ON THE SURVEY OPERATIONS IN THE LUSHAI AND NORTH CHITTAGONG HILLS.

From COLONEL H. L. THUILLIER, C. S. I., *Surveyor General of India, to* A. O. HUME, Esq., C. B., *Secretary to the Government of India,* DEPARTMENT OF AGRICULTURE, REVENUE AND COMMERCE, No. 160*F*, *dated Simla, the 22nd June* 1872.

I have the honor to submit, for the information of the Government of India, the professional results of the two survey parties employed with the northern and southern columns of the expeditionary force against the Lushaies on the Eastern Frontier under the command of Brigadiers General Brownlow and Bourchier, respectively, during the past field season of 1871-72.

2. As approved and sanctioned by Government on the recommendation of His Excellency the Commander-in-Chief, as conveyed in my previous reports cited in the margin, the two parties were organised and officered as follows :—

No. 411 F, dated 16th August 1871.
„ 496 F, „ 31st „ „

With the right southern, or Chittagong column, were the following officers of the Revenue Survey Department, *viz* :—

Major John Macdonald, Officiating Deputy Surveyor General in charge.

Captain H. B. Tanner, Deputy Superintendent.

Mr. Clifford Barrett, Assistant Superintendent.

Mr. Gorden Cooke, Assistant Superintendent.

3. From Major Macdonald's report* herewith attached, received this day, it appears that his party succeeded in establishing, under all the natural difficulties of this very peculiar and densely-covered country, added to those other obstacles and impediments attending on the advance of a military force in an enemy's country, a series of 27 first class secondary triangles, emanating from a well-constituted base of the Great Trigonometrical operations of the Eastern Frontier series, together with 76 minor triangles of a less rigorous character, establishing 40 well defined points, and covering an approximate area of about 2,300 square miles of country, lying between the parallels of 22° 30′ and 23° 45′ north latitude, and the meridians of 92° 30′ and 93° of east longitude, never before laid down or attempted to be penetrated.

* Dated 16th May 1872.

4. Of these points, the heights of 37 stations have been computed from absolute trigonometrical results, varying in elevation from about 2,000 feet on the Uephown Klang, or range of hills, to 5,300 feet on the Muifang range or 6,056 feet at the Shendoo village on the Purang Klang, Blue Mountain, towards the south-east of the explored territory being found, by intersection, to be 7,100 feet.

5. The country thus identified and intersected by fixed points formed the basis of the topographical details, which, during their marches with the different columns and various other detached routes, as the military considerations permitted them to take, the several survey officers sketched in by the plane-table, the mountain ranges and water-system to the extent of about 1,700 squire miles from the Burkhul Falls and Demagiri on the Kurnafoolee river, to the valley of the Koladyne and Burkoyas village on the extreme east, and in due connection with our old surveys in the Northern Chittagong Hills and Akyab, as shown in the preliminary map attached to the report, and which has been reduced and connected with the work of the northern or Cachar column in my office.

6. These results obtained, as fully described, only after many disappointments, and under very inadequate amount of coolie labor, not only for the necessary transport of the survey apparatus, but for the bare provisions and the absolute necessaries of life, may be said to be more satisfactory than at first we dared hope for and, under all circumstances, looking to the serious detentions at first starting, may be accepted with much thankfulness.

7. This preliminary general map of the entire results of the survey operations of both columns will, I trust, do more to explain the general effect of the new geographical information obtained on this frontier than any words of a professional report.

8. It will be observed that the two columns approached each other very closely about the parallel of 23° 30 not being more than about 40 miles apart in a straight line. But most unfortunately for the interests of this department and of geography in general, a junction was not formed owing to the lateness of the season when the final results of the military expedition were obtained, and it became essential to evacuate the country as fast as possible.

9. Thus a considerable gap, in conjunction with much else, intermediately between the southern boundary of the Cachar district and the northern limits of the present expedition, still remains to be filled up, which it is highly important, in a geographical sense, to become better acquainted with; and it is to be hoped that our improved relations with the tribes on this frontier and the good offices of the civil authorities may enable us hereafter to dispose of the whole of the blanks still disfiguring the map of India, and which have so long baffled all our attempts to describe, with even approximate truthfulness, the geography of our eastern territory.

10. The professional details of the survey operations are very clearly given by Captain Tanner in his report* and diary annexed to Major Macdonald's report. Of the arduous nature of such work in such a country, and under such hardships and difficulties, it is needless to enlarge; suffice it to say that the excellent officers and Assistant Superintendents engaged, fully realised the expectations formed of them when they were specially selected for this particular duty. Captain Tanner is an officer of rare qualifications and of the highest merit, and his untiring exertions throughout the whole of the campaign, as well known to the whole of the force, aided by two of the best civil officers attached to the Revenue Survey Department, Messrs. Barrett and Cooke, entitle them to the favorable consideration of the Government of India.

* Dated 31st May 1872.

11. Major Macdonald's and Captain Tanner's services were thus brought to the notice of the Government in the despatch of Brigadier General Brownlow, as cited in the margin, and in expressing my own acknowledgments to these officers for the success of the survey carried on under Major Macdonald's immediate direction, I would venture to hope that this officer's previous services during the seasons 1869-70 and 1870-71, in company with Mr. Edgar, C. S., from the Cachar side, on this frontier, and his labors under the most trying circumstances and privations, may not now be forgotten. I beg most earnestly to recommend Major Macdonald, who has done so many years' good and valuable service in this department, to the favorable notice of the Government of India for his special and lengthened services on the Eastern Frontier.

"VII.—The Survey Department, under Major John Macdonald, Deputy Surveyor General, with whom was associated Captain Tanner, Deputy Superintendent, achieved results which I have already referred to, and which Major Macdonald's report more fully describes. These officers were almost invariably present with the head-quarters of the Brigade and, in addition to their other duties, afforded me much valuable advice and assistance. Major Macdonald attached himself to the 2nd Goorkhas throughout the campaign, and took part with them in all their encounters with the enemy."

12. With the left, northern or Cachar column, were the following officers and assistants of the Topographical Branch of the department, *viz.*:—

Captain W. F. Badgley, Deputy Superintendent, in charge.
Lieutenant R. G. Woodthorpe, R. E., Assistant Superintendent.
" E. P. Leach, R. E.,
Mr. M. J. Ogle, Assistant Surveyor.
" W. Robert, " "
" J. MacCay, " "

13. From Captain Badgley's narrative report* herewith attached, it appears that, under similar circumstances as above described, the efforts of himself and party resulted in the attainment of a series of secondary triangles, emanating from a good side of the Cachar secondary series of the Great Trigonometrical Survey on the parallel of 24° 45' near the Bárák river, and extending about 25 miles in a south-easterly direction into the Lushai country on the Munipoor frontier, and covering an area of about 612 square miles. This, combined with 191 linear miles of route survey, formed a connected basis for the delineation of no less than 4,800 square miles of entirely new topography, or including overlaps, of 6,068 square miles as actually sketched and mapped, some portion of which was duly connected with the old Cachar survey, and executed after the return of the expedition to Silchar.

* Dated 16th May 1872.

14. These operations took the party down south nearly as far as 23° north latitude, the column of General Bourchier having traversed this considerable distance southward, and as far eastward as 93° 30' east longitude, and, as before stated, to within the short distance of about 40 miles only from the extreme limit of General Brownlow's march, the relative positions of the two distinct areas which have thus come under survey being clearly defined on the map herewith submitted.

15. The elevations attained by this party are—"Cheelam," 5,700 feet; "Tulcheng," 5,800 feet; "Muklung," 6,850 feet; "Kungnung," No. 12, 5,525 feet; No. 13 station 6,150 feet; "Champha," extreme south point attained by the force, 4,925 feet. From the valley of the Barák at Tipai Mukh, the expedition gradually ascended from 250 feet to the above heights.

16. On the return of General Bourchier's force to Cachar by the middle of March, I urged on the attention of Captain Badgley the necessity of availing himself of the opportunity to reconnoitre a good deal of the ground west of Tipai Mukh, with the view of rectifying the defective or uncertain topography of the southern portion of the Cachar district, as laid down in the old map; and this, I am happy to say, he has done with such good effect as to materially alter much of the details in the old map, and I believe the Cachar southern territory is now placed in a far more satisfactory state, and is as well defined as we can ever expect such ground to be.

17. Captain Badgley has achieved a most satisfactory amount of very good and reliable work. To his own share he accomplished the larger proportion of the above area, as specified in his report; and to his indefatigable zeal and energy we are indebted for this considerable addition to our knowledge of the country south and south-east of the Cachar district, previously totally unknown.

18. Lieutenants Woodthorpe and Leach, of the Royal Engineers, Assistant Superintendents, rendered good assistance, and have contributed, as far as their experience permitted, to the success of the work; they are both accomplished young officers, full of zeal and energy, and their sketches will, I have no doubt, add greatly to the interest and history of the campaign. These sketches are in course of publication, and will be reproduced by the photozinco process in my office in due course.

19. Messrs. Ogle, Robert, and MacCay, Civil Assistant Surveyors, have given great satisfaction, and performed every duty entrusted to them with great cheerfulness and success. Messrs. Ogle and Robert, specially, have maintained and increased their reputation as most zealous and efficient members of the department, ever ready to devote themselves to any duty, however difficult, and over any description of country.

20. Captain Badgley's report contains an interesting description of the country passed over, together with an account of the manners and customs of the people, which is worthy of publication.

21. Although Brigadier General Bourchier did not mention the presence of the survey party with his column in his despatches, yet I am authorised to state that he fully acknowledges the assistance he derived from the materials promptly furnished to him by Captain Badgley, whose preliminary map was made use of by the Brigadier-General to illustrate his own report and route.

22. The combined results of this short expedition in a country excessively hostile to survey operations, destitute of inhabitants, densely covered, and with military operations going on, are as follows :—

	Triangulation.	Topography.
	Square miles.	Square miles.
South Column	2,300	1,700
North Column	612	4,800
Total ...	2,912	6,500
Overlaps ...		1,268
GRAND TOTAL ...		7,768

23. It is not only this area of nearly 7,000 square miles of entirely new topography which has been obtained and mapped, but, by the correct delineation of the mountain ridges and the drainage of the country traversed, a far better idea of the general collateral run or configuration of the whole frontier has been obtained, and much which disfigured our old maps as absurdly conjectural, will now give place to what is more reliable and in harmony with actual survey.

24. What has been effected appears to me highly creditable to the energy, perseverance, and facility of resource of the several officers and assistants employed, upholding, as it does, the fair reputation and prestige of the department, and I express the hope that it may be so considered by the Government of India.

25. There is still left a good deal which it is desirable to define on or within the Eastern Frontier, before it will be possible to determine a fair and tangible boundary along the whole line, as referred to in Major Macdonald's 31st paragraph. With Captain Badgley's topographical party working in the Naga Hills and recessing at Shillong, and with their good knowledge of the country and aptitude for such operations, I shall be able to provide for all further work necessary to be done on this frontier, whenever it may be the pleasure of the Government to direct further surveys to be prosecuted there.

26. A new general map of the entire frontier, showing all these recent additions, is in course of preparation in my office, and will shortly be published, when the effect of all existing geographical information will be seen at a glance. The rough preliminary maps of each column, as now rendered, will also be replaced by the final and more perfect productions as soon as the fair maps can be drawn by executives and reproduced at head-quarters.

27. It will be obvious to the Government that in rapid surveys and reconnoisances made simultaneously with the march of an advancing military force, the survey officers must be dependent for success on the extent of the aid and assistance rendered by the military commanders. This department, therefore, desires to acknowledge in the fullest manner the hearty and generous co-operation and aid of Brigadiers General Brownlow and Bourchier and their staff, who did everything in their power to facilitate the survey operations, and to admit of the executive officers obtaining all the geographical information in their power. This object, I know, was frequently gained by sacrifices made by the Brigadiers General, with respect to other and more important requirements, and therefore calls for special and grateful acknowledgment.

Vide paragraph 34, Major Macdonald's report.

28. These survey operations were conducted on principles in conformity with the full general instructions issued for the guidance of the officers employed from my office, based partially on the experience of the survey officers employed in the Abyssinian expedition; and although the two countries were widely dissimilar, yet, I believe, by a proper attention to the chief heads of instruction issued, the results have proved as satisfactory as the peculiar circumstances met with would allow.

Extract from the Narrative Report of No. 6 Topographical Party, for the Field Season of 1871-72, with Brigadier-General Bourchier's Field Force, Northern or Cachar Column.

From—Captain W. F. Badgley, b. s. e., *Officiating Deputy Superintendent of Survey, in charge No. 6 Topographical Party, No. 264, dated Shillong, the 16th May 1872.*

Description of country.—It will be better to consider the country in sections, beginning with the most westerly portion surveyed. This includes a third of South Cachar and a strip some 25 miles broad of Lushai country, the whole quite uninhabited, except where the Dallesar river, which is navigable for small craft of 100 maunds (?) throughout the year, has enabled the advancement of tea plantations as far as Jalnacharra, which, however, as well as one or two other gardens in its neighbourhood, is, I understand, considered too far forward, but only so on account of the difficulty found in retaining workers in what appears to them an unprotected position,—a matter which, however, a more thorough system of outposts and defence will soon rectify.

Five parallel hill ranges running from south to north intersect this country, and gradually lessening in height, are lost in the plains of Cachar. Between these lie four broad valleys, broken by innumerable small ridges and swamps, and in three cases drained by considerable streams more or less navigable for country boats.

Hill ranges.—The first of the ranges beginning to the westward is the Chattarchura. This, which is about 3,200 feet high at Chattarchura peak, is lost in small tilas at Alexandrapur. Along the entire ridge, as far as I visited it, and it is said continued into Chittagong, there is a broad elephant track, which, with a few hanging branches cleared away, might be used as a riding path. It was along this that the Lushais made their raid on these western gardens, and the remains of their encampments still point out their halting places.

The next range is the Bairabi, the highest point of which, 1,800 feet high, ends south of Burancharra, from whence northward a band of low knolls and ridges extends as far as Cachar.

Between the Chattarchura and the Bairabi, runs the largest of the rivers of which I spoke, the Dallesar, which winds between high banks with a moderate current, and has been found navigable throughout the year to Pachwa Mukh, and is so probably much further. The country through which it runs is, however, I believe, entirely uninhabited as far south as peak Z. Its principal tributary is the Gutar, which running from far south in a nearly direct northerly line joins it at Gutar Mukh; for thirty-five miles of its course this stream drains an uninhabited country. East of the Bairabi is the Koloshib range. The valley between is drained by branches of the Dallesar; it is an almost impenetrable tract of forest covered with low ridges and cane-covered swamp, which will probably not be opened up for many years to come.

Mr. Ogle, to whom fell the survey of the country from Koloshib eastward to the Buban range, has obligingly furnished me with notes, from which, merely premising that the general description is the same as that of the country to the west, I give the following extracts.

"The principal rivers in this tract are the Sonai and Rukni. The only large feeder of the former is the Tahsul Khal, and of the latter the Chem. This stream, in maps hitherto published, is made to join the Rukni eighteen miles further north than it actually does, and other smaller feeders, as the Noturcharra, rising near Parsansip, and the Tezia, are not shown; and herein lie the chief discripancies between previous maps and the season's survey.

"The Rukni runs with a rapid current, and, to its junction with the Chem, holds a considerable body of water. It is navigable so far for ten-maund boats at all times, and during the rains much further south. The Sonai, which has a much longer course, is not navigable much above Monir Khal.*

* Mr. Edger got small boats as far as Lushai Haut.

"Valuable timber is found in the valleys of these streams, which after being cut is dragged to the bank by elephants and floated down. Occasionally the wood-cutters are surprised by Lushais, who levy a tax on them of a rupee a head.

"There are numerous elephant tracks all over the country, which are utilized by the Lushais on their raids. Those usually used run along the tops of the main ranges. There is one from Tipai Mukh crossing the Buban range near L. 4 peak, skirting below it to the west, passing along the ridge of Dome peak, and thence joining the Monir Khal and Mainadhar road at Nága Khal. Another of their roads runs along the Parsansip ridge and over Bongong; this gives off a branch four or five miles north of Parsansip which turns down to the Sonai and follows the river. A third track is on the Koloshib range, and extends to Sonárban."

The easternmost of the Cachar ranges, the Buban, has its highest point (3,100 feet) between Monir Khal and Mainadhar. It ends south of Lakirpur. Between it and the Nunjaibong range, eight miles to the east, runs the Bárák, which is here the eastern boundary of the Cachar District, Munipur being across the river.

The Bárák.—This fine stream, though it drains all eastern Munipur and the north-east of the Lushai country as far as the Burmese frontier, is, owing to its rapids, impracticable except for ten-maund boats between March and June. During some months, however, the largest boats can reach Tipai Mukh.

Up to Tipai Mukh, the Bárák, running to the east of the Nunjaibong range, has a south-easterly direction, but from this, on receiving the Tui Vi, it changes to nearly due north, and keeps so as far as Alni. There is not much to notice about this part of the Bárák Valley. The river takes its course to the north, receiving the drainage of the hills on either side, which throw out numerous spurs, becoming lower and more broken as they descend, and covered above with timber and bamboo, and below with bamboo, cane, and other small and dense jungle. Fortunately for the Surveyor, elephant tracks were found here and there leading from the river to the hills, without which the prosecution of the work would have been immensely laborious.

South of Tipai Mukh begins the country of the Lushais. The part of it which, taking Tipai Mukh as its north-west corner, would be included in a square of 40 miles side is drained by the Tui Vi, or as pronounced by Hindustanis, Tipai, the principal feeder of the Bárák. South of this square the waters flow into the Kolodyne. A number of parallel north and south ranges intersect the country, and through these the Tui Vi winds and doubles till it has completed from its source, south-east of its debouchure at Tipai Mukh, a course of 125 miles, the direct distance being 50.

Tipai Mukh.—Tipai Mukh, the depôt to the expedition, a small breadth of open space consisting of a sandbank, a bit of shingle, and a ledge surrounded by hills, was the largest piece of open country we saw from Alni to the Champhai. Its height is 250 feet, and it was comparatively healthy till the hot weather and cholera set in. Diarrhœa or dysentery every one had, but so they had at most of the other camps at the beginning of the campaign. That a place so low, foggy, and damp, and crowded with coolies and boatmen on whom it was difficult to enforce sanitary rules, was not more sickly is probably due to its being washed by the two rivers.

From Tipai Mukh the route of the column lay at first south-east and then south, up hills and down to valleys, each rise being between 2,000 and 3,000 feet. The first ridge, Senbong, is 3,450 feet above the sea, and beyond this the hills rise higher and higher to Kungnung, a point on the range south of which was 7,000 feet or more in height. From this the highest ranges lie north-east and south south-east, and between them and Burmah, which is shut out by another towering ridge, the country is crossed by lower lines of hills, all keeping the general north and south direction. These are higher somewhat as they approach from north and south the watershed line of the Bárák and Kolodyne, but not remarkably so: one point on the line we found to be only 5,150 feet, and others were lower.

As we advanced into this magnificent country, a country of steep ridges and narrow valleys, we found the hills less covered with forest, the under-wood lighter, and the valleys dry and lined with grass instead of bamboo, reeds, and cane. We noticed oak as the principal timber, with fir and rhododendron on the highest hills; but there were many more trees unknown to us, among them one, of which we saw some magnificent specimens, called by the inhabitants Bongpui. It was before the season of flowers, but blackberries, strawberries, violets and several of the common English wild flowers had begun to show themselves, and in the woods the scarlet rhododendron and a species of Dâk (Butea) were in blossom. The oaks, of which there were several species, were hung like those on the Himalayas with streamers of grey moss, and the trunks and larger branches covered with small ferns and orchids. Of ferns there were a number of varieties; cinnamon, wild ginger, and other roots were to be found, as also in some places the lemon; but these last were said to have been introduced by the Kookees, the former masters of the country, and were only met with near old cultivation.

Formation.—The rocks were sandstone, with here and there clay slate.

Reptiles, insects, &c.—We saw no snakes, and very few of those disagreeables in the way of leeches, tick and fleas, which we had been led to expect to be bothered and eaten up by.

Scenery and climate.—The scenery is very fine, the country healthy, and the climate during our stay delightful on the hills, with very little rain and hoar-frost in January. In the valleys the nights and mornings were chill from the mists settling on them, and making trees and herbage damp and dripping. This cloud effect was grand seen from above—like a sea of snow, with the dark peaks rising from it like islands; a most difficult subject for a sketch, but which Lieutenant Leach has attempted to represent with considerable success. Of prevailing winds there was no particular indication, but the clouds and rain always came from the south-west. The rains probably begin early.

The Lushais.— The Lushais, of whom we met men of four different tribes, are fairer than the Bengalees, of a very uniform height of about five feet six inches, well made, active, intelligent, and energetic. Of their figures we had one or two opportunities of judging, especially on one occasion when some iron hoops of burnt barrels were in the fire, to get which, and to save their clothes from accident, they stripped,—an easy operation with men whose only covering is a large square of cloth. The figures they displayed were splendid, full and finely muscular, especially about the shoulders and calves, though in the latter they showed a more graceful shape than the large-legged Kookies and Nagas who were with us as coolies. That they were intelligent, we had, not knowing their language, less chance of forming an opinion; but from what we could judge from a few who understood some words of *Hindustanee*, and from their quick recognition of sketches, even in outline, and from their looks, which otherwise belied them, they were so. Of their energy and activity their raids are sufficient proof.

Their heads are well formed, with good foreheads, oblique eyes, heavy eyebrows, high cheek-bones, depressed noses, large but not thick lips, and scanty beards, a few straggling hairs in some being the only representatives of chin-tuft or moustache, beyond which none of them can boast. Their hair is straight and black or brownish, eyes brown or black, and teeth invariably good; their expression open, bold, and generally pleasing, and their voice loud and sonorous, partly probably from practice and education; the children having the same deep far-sounding tones when calling loudly.

Costume—Their dress is admirable in its ease; no boots, nor breeches, nor other tight clothing confine the freedom of their limbs; a large square cloth or two put on together, according to the temperature, is their only covering, which is worn passed under the right arm and with two corners thrown in opposite directions over the left shoulder, and managed for modesty with the most easy dexterity. To confine the cloth upon the left shoulder they carry, when anywhere from home, a bag slung so as to rest behind the right hip, the shoulder strap being of skin, tigers's apparently by preference, and the bag, which is of fine and strong net, covered with a large skin flap somewhat like a sporran, and often made of long white goat's hair, with three black streaks. In the bag they carry their smoking apparatus, flint and steel, a dhao or large chopping knife, and occasionally a bundle of *pangies*, which are small hardened bamboo skewers, and which stuck in the ground are very efficient protection to their owner when sleeping in strange places, and left behind him in his path, protect him in some degree when pursued.

Lushai Tribes.—We saw, as I said, men of four separate tribes, three of them distinguished by their mode of wearing their hair, and the southern tribes rather smaller and handsomer than the northern. Those we first met who had come from Kulel, and are now living on Banbong, called themselves Howlongs, and are governed by an old woman, Impanu, the mother of their former chief Vonpilal, whose grave on Kulel is one of Lieutenant Woodthorpe's illustrations. The name of the next tribe, those under Poiboi and Lal Bur, I quite forgot to ascertain. The remaining two were Pois and Paites. The former were inhabitants of

the country south of Lál Bur's, who had apparently hired themselves out as soldiers, and the latter, probably a very small tribe, living on and about Nurklang. Of these the two first wore there hair drawn smoothly back, and fastened in a knot behind by a thin bit of iron bent into a double prong. The Pois parted theirs across the head behind, and letting the lower part hang loose, drew the upper forward, twisting it with the front hair, tied it in a knot over their foreheads, where it was secured by an iron skewer or with a comb of ivory; round this knob, those who wore turbans tied one end in, putting them on after the manner of the Sikhs, which was remarked by some Lushais, who called the 22nd Poie; about a fourth of the Pois wore turbans, the other tribes, as a rule, going bareheaded. The Paités wore their hair frizzed up from their head, and cut about four inches long. Chiefs and headmen wear feathers in their hair knots on great occasions, that is, those who have them; how the Paités wear them, or whether they use any, I do not know. Of the Suktis, who live to the eastward, we saw next to nothing; they are at enmity with these other tribes, and thinking to take them at a disadvantage, had, just before we reached the Champhai, made an attack on Lál Bur's village of Chouchim, whence they had been repulsed with loss, leaving one body behind. This unfortunate's head and some limbs had been placed as ornaments to Vonolel's tomb in Lungvel, but as it had been scalped, gouged, and the skull smashed in, little could be made out from it.

Manners and Customs.—There are two things remarkable about these people—one, their indifference to ornaments; excepting two, which are very simple, they wear none; these are a tiger's tooth or tuft of goat's hair tied with a string round the neck, and a small tuft of scarlet feathers stuck in, or an amber bead hung by a string to the ear. Some of the children wore strings of beads, but very few of the men; and coloured chintz was scoffed at as a barter, though anything might be got for plain red or white; silver and gold have they none, and care little for, a few pice re-purchasing a rupee; but these are at a premium merely because they can be beaten into bullets or used to line pipes. The second is, that though not particularly cleanly, they are entirely free from any of those noisome skin diseases which are so common in Cachar, and only one man did we see marked with small-pox.

We saw no dwarfs or cripples; probably they are made away with early, after the Spartan fashion.

Qualities.—Of the mental and other qualities of the Lushais, as far as one could judge, they are quick-tempered, unstable in mind, loose in allegiance, thieving, and occasionally given to drunkenness, voilence, and barbarity; inquisitive, taciturn in conversation, patriotic, and too bold to be liars; their bump of locality must be strongly marked; they are great hunters and athletic, walking long distances and climbing with remarkable ease. From the smallest children they all smoke,—men and women,—and so much are they given to it that any of their recent camps can always be detected by their stale tobacco smell. Their pipes are neatly made of bamboo lined with iron or copper, and of the ordinary pipe shape for the men, those used by the women, having a receptacle for water, after the fashion of a bubble-bubble, which water—disgusting practice—is carried about by the men in little gourd bottles to take occasional nips from.

Religion.—They have some sort of belief, but I heard no mention of priest, nor were there any temples or images. Occasionally, in the field, we met with a little cleared space on which were arranged rows of clay pallets of various shapes, with a yard long flag-staff and coloured pendent waving over them; but it was in their tombs that we saw the greatest evidences of their religion. These were always in their villages and ornamented with trophies of skulls of animals and feathers. At burials they discharge firearms over the graves, and I believe slay the animals, whose heads afterwards go to their decoration, and whose spirits are intended for the delectation of the grave's occupant in the happy hunting grounds. The greater the man, the more animals are sent with him, and it is said that slaves are sometimes sacrificed and buried with a chief. Vonolel's and Vonpilal's tombs had the heads of many beasts over them (indeed one got a knowledge of the larger fauna of the country at a glance), the skulls of the most dangerous were muzzled, and there were hobbles to restain the feet.

Beyond what can be gathered from what I have mentioned,—that they must believe in a future state, and that there is some invisible power for evil against whom they make their incantation to protect their crops,—I could not discover anything, excepting that the tiger's tooth or tuft of hair which the men wear about their necks has a religious signification.

Their language is not monosyllabic like the Khassia and others, and there is no written character. Tradition is probably handed down by songs, which are of their battles, their hills, and love; and they can improvise. One night a party were invited to give us a specimen of their performances, and the first of the songs was on the subject of our expedition. They chaunt them in soft deep notes to the accompaniment of a drum and a set of weak organ-like pipes, whose stops include an octave; and the love song they afterwards gave us was acted to in a posturing dance by one of the number, at first slowly, but as the story went on, more and more quickly, till the corn cob which represented the young woman sung to was snatched up and whirled round quite excitedly.

Sport.—I have said before, I think they are mighty hunters; everything that runs or flies is game with them, from an elephant to a field-rat, from a hornbill to a wagtail; and they have many and clever devices for bringing them to the pot, using, besides firearms, traps and fenced drives for the larger, and springs for the small game, and for small birding employing the pellet-bow.

Game should be plentiful, judging from the numbers of heads we saw in front of the houses, which are not preserved beyond the owner's lifetime. These were of elephant, tiger, leopard, sambur, hog-deer, metna, pig, and monkey. This last—the hulak or howling monkey, black-faced, grey-whiskered, blackbodied and tailless, with very long arms and of extraordinary activity—is an abominably noisy beast, with a cry beginning with a yell and ending with a series of howls like men imitating jackals; they are always started by the way in their discordant chorus by a single sharp cry from one of them, which my fellows called the raja.

Of birds I saw the skulls of some cranes, and they have besides many which I did not find out—hornbills, jungle fowl, partridges (francolines), chir, and black pheasants.

Fish.—Of fish I only saw two varieties, the mashir and a small silurus, called in the north-west sol. They use nets, and also, as is the custom elsewhere, poison the water with the juice of a cactus which kills the fish without spoiling them as food, and in one place the camp on the Tui-burn, they had built a large dam and weir apparently for fishing purposes.

Fighting qualities.—Their mode of war is of surprises and bush-fighting and their ideas of bravery are amusing. At Vanoog (the first fight) they called out to the sepoys not to stick like cowards in the open, but to come against them in the jungle like men. For weapons they have flint-locks, some wonderfully old, dating back to Culloden, spears and dhaos; we saw a few leather shields, but no bows and arrows. For defence, though their villages are lightly palisaded, they prefer the employment of stockades in difficult passes defended by entanglements, a specimen of which, which was quite a lesson in military engineering, we met with, fortunately undefended, a mile or so from Poiboi's village of Tulcheng. I have been told, by the way, that the village of the chief is never palisaded, his outlying villages being guardians against attack, or at least unprepared for attack.

Raids.—They carry on feuds and make raids among themselves as well as on Munipur and the eastern provinces for arms, ammunition, women, and heads. When on raids they travel with remarkable celerity, carrying nothing but their arms and enough of rice for the journey, a fresh joint of bamboo at each new camp serving every purpose of water jar or cooking pot. About to make an attack, they are told off in three parties, gunmen, spearmen, and men to carry off the wounded on retreat; if they have been successful, and have made prisoners, the men are made to carry the provisions, and though they sometimes retain a few as slaves, specially Munipuries and Kookies, the carrier is, as a rule, relieved of his head when he has been relieved of his burthen. I think it was after the raid on Monir Khal that a body was found—a garden cooly's—which appeared as if an incantation had been practised by it; the head was not removed, and the chest was cut open and filled with boiled rice: why so I could not find out.

Notwithstanding their cruelty, they are fine fellows, taking pride in a fight, dressing themselves in their best and neatest for the occasion, and showing in their own way considerable pluck; and in their communities I imagine they are moral and courteous, the ever-ready dhaos being a potent preventive to bad conduct and bad manners.

Muntries (heralds ?), men wearing feathers and red puggries, are employed among these people to treat of war and peace and all matters, and at all times pass free; but besides these verbal means of communication they have modes of spreading intelligence known to themselves, as by fire signals, alarm drums and gongs, and others. A tree exuding a red sap, hacked and struck with spikes, is a serious warning; a red gourd stuck in a tuft of grass means bloody heads for those who persevere in advancing beyond it; a branch across the path is a notice not to go further, and a bamboo split, broken, and burnt means fire and fury.

Stockaded villages.—A Lushai village is usually built in a position which gives natural advantages for defence. It is slightly fenced, and the approaches guarded at difficult points by palisading, loop-holed, and strengthened by heavy stones, and on commanding viewpoints there are out-looks. The conservancy is admirable, and the houses, though smoked, begrimed from having their fire-places inside, are clean. Each house usually has its own enclosed patch of fenced kitchen garden to one side, and though not built perfectly symmetrical, they are ranged to form streets. In the middle of the town is a large house used as a town hall.

The frame-work of a house is of wood for the posts and beams, and bamboo for the roof; the floor is raised a few feet above the ground, and is laid with bamboo split and beaten flat, the walls being of the same material, woven in a large chequer pattern with very neat effect; the roof is a thatch of grass and palm leaves. The average dimensions are 80 by 12 (Poiboi's was 40 yards long), of which the first third is left open; a ramp of logs leads up to them, and on one side of the ramp is a platform for sitting out in fine weather; under the

caves are the fowl-houses, and hung over the house front are the skull and horns of animals captured in the chase. The interior, which is closed by a neatly-made sliding door, is usually undivided ; in some a half partition portions off a part as a granary ; a door at the back leads to a small platform behind. In the middle of one side an open fire-place is made of slabs of stone, above which hangs a frame for smoking meat and fish, and beyond it is usually a raised place for sleeping on.

In the open front of the house is the pig trough and the mortar for cleaning rice—a work done by the women daily. This rice, which is of large white grain and very nutritious, forms their principal food, and is grown by dry cultivation on cleared spots on the hill sides.

Agriculture.—Their method of agriculture is—having selected a patch of jungle and marked it by putting arrows in the split stumps of small trees round it, to fell and burn it when dry just before the rains, and scattering the ashes to dibble in the grain with dhaos, deserting the spot after three years when the soil is worked out. The crop cut at its proper season is threshed and stored on the ground till the end of the harvest, when it is carried in by the women in large baskets slung by a band across the forehead, their mode of carrying all burthens.

Besides the rice they raise maize, a sort of yam, sweet potatoes, beans of several sorts, ginger, tobacco, pot herbs, gourds, esquashes, cotton, plantains, and plants giving a dark-blue dye, and they domesticate pigs, goats, dogs, fowls, and pigeons, all for food ; milk they never touch, and the metna, which they allow to roam half wild, is kept only for its flesh and horns, the latter being made for one thing into powder and priming flasks. Sugar is a thing they do not seem to care about, but they liked our rum, and themselves prepare a liquor from rice which has a pleasant taste, and is drunk well diluted by suction through reeds from the jar in which it is made. We called it hill beer. Their name for it is "ju."

Manufactures.—They manufacture everything necessary to their simple mode of living—cooking and liquor pots, wooden platters, baskets, salt, saltpetre, cotton cloth, dhaos and axes. The earthenware is moulded. The baskets are of every shape and size, from the store basket, which will hold 50 maunds, to the little thing which holds the woman's needles and thread ; they are woven of shreds of bamboo with great neatness. Gourds and bamboos are used for water.

Their apparatus for cleaning, carding, spinning, and weaving the cotton is similar to that in use in Bengal. The cloth is very strong and close-grained, in breadths of three feet, unbleached, with a narrow blue border, or dyed entirely blue. Some of the cloth used by them, resembling a dark tartan, is said to come from Munipur. Salt they manufacture from the ashes of bamboo leaves, and saltpetre from cowdung urinated on. Their forges are not in any way remarkable, a pair of large bamboo cylinders being the bellows ; but they turn out remarkably good arms, working up the iron which they get from elsewhere to suit their own tastes as to shape. The axes are of that peculiar construction used among most of these tribes—a flat-ended peg tied in a socket in a bamboo handle.

There are no archæological remains, excepting the rough slabs, with rough outlines of figures cut on them, which cover old graves ; and there are no roads, communication being by footpaths, which in the more populated parts are broad and easy.

I had almost forgotten to mention the women, but we saw so little of them : they are pleasant, round, flat-faced creatures, continually smoking, and lively among themselves ; their dress is a scanty blue kilt, and cloth thrown over the shoulders, with the head usually uncovered, and the hair loose or neatly braided. They wear no ornaments. They vary in color, some being quite fair with rosy cheeks. Their children are carried on their backs.

The products of the country are India-rubber, wax, and ivory, usually bartered for salt. The traders are mostly Munipuries. It is, I believe, intended to attempt to open up the country by instituting a periodical fair at Tipai Mukh. The project would be sooner successful were it not that unfortunately the Tui Vi is unnavigable. Tipai Mukh is not suited for a military post, but in future years, when our rule has been extended to this country, many strong and salubrious hill positions will offer themselves for choice as stations, and the valleys attract the sportsman when there is no longer the danger of his being the pursued instead of the pursuer.

From LIEUT. R. G. WOODTHORPE, *R. E., Assistant Supdt., Topographical Survey, to* CAPTAIN W. F. BADGLEY, *Offg. Depy. Supdt. in charge of Survey with Lushai Expedition, dated Shillong, the 10th July* 1872.

In accordance with the instructions contained in the Surveyor General's letter No. 183F, dated Simla, 26th June 1872, I have the honor to forward the following notes on the country passed through by the left column of the Lushai Expedition of 1871-72. As anything which I could say concerning the Lushais themselves, their villages, warfare, &c., would be simply a repetition of your descriptions in the narrative report already submitted to the Surveyor General, I have confined myself more particularly to a description of the route as aforesaid.

2. The country about the station of Silchar is flat and open, but with the exception of the road to Munipur the communications are not good, and in some places mere tracks through the bheels or swamps which abound in this district, especially towards the foot of the Bhuban Hills. My first experience of the swamps and jungles of these hills was on the 17th December 1871, when, having arrived at Bewalia tea garden the evening before, we* started that morning for the point known as "Bhuban cliff" with the view of ascertaining its suitability as a survey station. Our way for about three miles lay through very long grass jungle and swamps, through which we should have had great difficulty in finding our way but for the kindness of Mr. Willington of Bewalia, who gave us two garden coolies as guides. There are a stone god and goddess set up in a romantic spot near the summit of the cliff, and thither the garden coolies and others make periodical pilgrimages, and their path was the one we followed.

Description of country.

* Mr. Ogle and myself.

3. On emerging from the long grass, we ascended and descended a succession of little *tilas*, some 300 or 400 feet in height, crossing a stream of excellent water several times till we arrived at the foot of a long spur, up which the path led very steeply for a continuous ascent of 1,800 feet: here the path turns along the main ridge for about five miles, when the cliff is reached. The top of the ridge, as seems to be the case with the whole of this range, and most of the Lushai hills also, we found to be but thinly wooded, there being very little undergrowth to impede our progress. There was a good spring of water close to the place of worship. A clearing had been made on the cliff, from which a good view of Munipur was obtained. The whole of the hills of this country appear to be densely wooded and very difficult, as indeed we afterwards found them to be; the jungle on the lower ranges and spurs is principally bamboo and cane, but higher up the India-rubber, Nagasur, and other large trees flourish. On returning from the cliff, which was found to be utterly unsuited for a station, in consequence of higher peaks on the same range shutting out the whole of the view to the south, we proceeded to Mainadhar *viâ* Monir Khal. The character of the country all along the foot of the "Bhuban" seems to be similar to that already described. The path from Monir Khal over the hill to Mainadhar runs strangely over the highest part, but, though certainly steep, in my opinion, could with a little engineering have been rendered, at any rate, as passable for troops, &c., as that taken round by Luckipore, which besides being longer was a series of rises and falls of a most fatiguing description, instead of one long ascent and descent. The hills afterwards encountered in the Lushai country were much more difficult than this route would have been, and roads were successfully engineered on them.

4. *Water.*—It was imagined that there was no water in the path from the foot of the hills on one side till Mainadhar was reached on the other; the first party of the survey under Captain Badgley, however, in passing over it discovered a very good spring almost at the highest point, and the water-supply was afterwards found to be sufficient for 400 coolies without any sensible decrease. The jungle on the hill side as the path descends into Mainadhar is almost entirely bamboo fortunately, as thus no difficulty was experienced in constructing the godowns and barracks which speedily covered the several acres of flat unoccupied land which stretches along the bank of the river below the lines of the labourers in the tea garden. The River Bárák presents many beautiful little pictures of water and woodland, and Mainadhar is not wanting in the beauty conferred by richly wooded hills coming down to the water's edge, broken here and there by masses of rock shading deep pools; on the left bank the yellow *tilas* dotted with the tea plants diversify the landscape, the whole forming a most pleasing scene.

5. From Mainadhar the road runs along the Munipur bank as far as about half way to Tipai Mukh, where it again crosses to the Cachar side; the troops being carried over by means of a floating bridge of ingenious construction. A strong cane rope is fastened to large trees on either bank and hangs slackly in the water; a large bamboo raft is swung to this rope by a couple of cane loops, and is worked by men sitting on the edge of the raft and hauling on the main rope.

6. The character of the country between Mainadhar and Tipai Mukh is the same on both banks—high and narrow spurs separated by deep and dark ravines thickly clothed with cane and bamboo jungle and tall forest trees, from which huge creepers hang in graceful festoons, while between these, tangled shrubs and thorns and long rope-like roots occupy every inch of ground. Elephant tracks or small paths used by wood-cutters are met with in many parts of these jungles, and it was by means of these that the military road was projected. Tipai Mukh, as will be seen from the plan accompanying Captain Badgley's narrative report, was admirably suited for a camp and depôt; a large open piece of sand and shingle on each side of the Tipai at its junction with the Bárák affording ample space for all requirements.

7. This open space is no doubt part of the bed of the river, but at this season it was perfectly dry. The disadvantage of the situation was that it was low and immediately surrounded by hills rising to a height of 1,000 or 1,200 feet above the river, and every evening as the sun sank behind the western ranges fog and mist slowly settled down upon the camp, remaining till late each morning. The Noonjaibong range, on each side of which flows the Bárák, ends here in a very narrow ridge, whose steep sides are almost entirely covered with bamboos, and the banks both of the Bárák and the Tipai are very rocky. The road from Tipai Mukh to No. 6 gradually ascends a spur of the "Senoong" Hill; the jungle is of a similar nature to

that on the Mainadhar road, though perhaps a little more open: along the ridge the road runs nearly level between No. 6 and "Senoong" Hill, on which a survey signal was erected. Mr. Edgar considers that this "Senoong" range is a spur of the great range overlooking the valley of "Kowpoom," and that Kholel is a continuation of that range; the survey operations were not sufficiently extended towards Munipur to enable us to verify this supposition; from an examination of the portion we did succeed in mapping, and also of Lushai Hills, it will be seen that all the ranges north of the Tipai are connected at various points with a high range running in the direction of "Kowpoom"; supposing that the position of this place is shown correctly on the earlier maps of the Eastern British Frontier, it seems, therefore, highly probable that Mr. Edgar's conjecture is the true one.

Hill ranges.

8. Before reaching the top of the "Senoong" range, only a few glimpses of the Lushai Hills had been obtained at intervals; from the survey station, however, a most extended view presented itself, which I shall endeavour to describe. Looking a little south of east the first range is the spur ending abruptly in the hill of "Pabarchang" with every shade of "verdure clad;" beyond this are the high peaks of the northern part of the Kholel range and the spurs of Bargpinlong, in which the dark green foliage is broken and relieved in many places by the sandstone and red clay, of which these hills are formed. In the distance is faintly seen the northern peak of lofty "Sungleng;" south of these and above "Pabarchang" the hill of "Chepin" appears brown and grey from the numerous jooms which cover its face and long level spur, on which stands the village of "Chepin," having from this stand-point the appearance of being strongly stockaded, —an appearance, however, which is deceptive, and in a nearer approach is found to be due to the small fences with which nearly every house is surrounded. Beyond "Chepin" bluff Surplang stands boldly out against the sky, and extending south from Surplang Moothelen and Lengteng are lost to sight behind the higher portions of the Kholel range, on which is visible the site of Vonpilal's great village, where still stands his tomb, a black speck on a long bare yellow ridge, forming a land-mark for miles around.

9. The slopes of this range are much cut up by numerous narrow spurs running down on either side to the Tipai. Looking down the valley of the Tipai, the scene is closed by a lofty remarkably-shaped hill, sloping gently eastwards, but terminating abruptly and precipitously on the west: this is known as Momrang. The southern hills are hidden by the near range of Vanvong, a long level mass, with broad spurs, from which much of the forest has been cleared for the villages and jooms of the people, who, on Vonpilal's death, removed thither from Kholel; but to the south-west and west Chelfil, Peak L, Noongoai, and Rengtipahar stretch far away, range upon range, till lost in the golden haze of the afternoon sky. Just beneath the station on "Senoong" the road turns down a steep spur and soon finds itself once more in the depths of the lofty bamboo jungle which clothes the banks of the "Tuibum." Between Tipai Mukh and the "Tuibum," near the sites of old villages, many fragrant limes and walnut and cinnamon trees were discovered.

10. The camp on the "Tuibum" was in a low unhealthy situation, but the scarcity of water on the higher ground prevented the establishment of a large camp and depôt for stores anywhere but on the banks of this stream. The road between "Tuibum" and No. 8 camp crossed Paharchang and descended to the Tuitu: the banks of this little river are covered with bamboo and a very tall, graceful, feathery reed. I may here mention that bamboos flourished in the neighbourhood of every stream till we crossed the Moothelen range, after which the general levels were much higher and the bamboo was seldom met with. The path from the Tuitu ascended steeply the Meidel hills through old jooms, in which wild heliotrope, coxcomb, and other flowering weeds flourished in great luxuriance. Between Kholel and Chepin, the Tipai is still a big stream, flowing rapidly over and between immense rocky boulders; the path thence to the village of Chepin ascends through some jooms, and then becomes very rocky and difficult, precipitous masses of rock overhanging it, small streams and miniature waterfalls occurring many times during the ascent.

11. The "Chepin" hills consist of three high peaks in a cluster, the northern slopes descending precipitously to the Tipai; one spur is sent out to the north, on which is built the village of Tingridum; to the south-west and south long level spurs extend the longest, to which the name of Gnoupa was given, runs due south for about ten miles, where it joins the Lengteng range. From Chepin we got a very fine near view of Surklang, Lengteng, Moothelen, and also of the Lungtul and Lungleng ranges. All these present strikingly different features from the western hills, being much more rocky and less covered with forest, long grass taking its place. Lungtul, which is perfectly square-topped for some distance, presents the appearance of an almost perpendicular buttressed wall, the buttresses being represented by a few sharp steep spurs; trees appear only near the summit, and the rocks peep out through the grass in a series of regular horizontal strata. In Lungleng, large and wild wooded spurs alternate with the steeper faces; in the latter the horizontal strata of rock are again visible; in Surklang, however, these strata are more or less inclined, often lying nearly parallel to the general slope of the spurs and ridges.

12. This curious hill, or rather mass of large hills, the highest peak of which is nearly 7,000 feet, tossed about in wild confusion, would appear to have been thrown up during some great convulsion of nature. On the south-eastern spur of Surklang is the village of Taikum, which was destroyed on the 20th January. From this village and the approach

to it an extensive view over the eastern hills was obtained, some high mountains towering far off on the horizon appearing to belong to Burmah. On the nearer and lower ranges were many villages; these dependent on Porboi, some of which, Mr. Edgar tells us, have now gone over to Munipur. South of Kungnung our way lay along the western grassy slopes of Moothelen, crossing two or three very rocky streams, and, going over the saddle which connects it with Lengteng, descends to the Tuignan, a very pleasant little stream with a gravelly bed running through a flat piece of ground, with an elevation of 5,200 feet, and covered with very fine forest trees.

13. The country for the rest of the route was much more open, the soil was less fertile than heretofore, and on the grassy slopes the bracken abounded. The road between Tuignan and Sellam led up the side of the Lengteng hill and over a very high rocky precipice, down which a little stream dashed with force; a little further on, descending into the valley of the Laiva, to the right of the path, a magnificent face of weather-beaten rock was visible, extending for about 100 yards, with a height of about 400 feet; on the other side of the Laiva we came upon a large flat grassy patch of land of a similar character to many which we afterwards passed through or saw, but which we had not hitherto met with.

14. The group of villages known as Sellam or "Chelam," as some of the natives pronounced it, is built on the southern slopes of a range of high peaks, which, rising some 300 feet above the villages, protect them from the northerly winds. The bleak sides of these hills are covered with the stubble of old jooms, blackened stumps still standing, and huge trunks of trees lying about in all directions. The view, looking south and east on a fine day, is magnificent; an endless sea of peaks stretching away far as the eye can reach, lighted up by a thousand soft and delicate tints; and nearly due south, distant some 14 miles as the crow flies, Dilklang and Murklang towering above their fellows, like two giant warders, guard the entrance to Laiboora's country; between these and Chelam lie many deep valleys and many high ranges, the sides of which are cut up by numberless gloomy gorges and dark ravines. Very drear and threatening does this country look on a stormy day, and very cold was our camp at night; in the early morning often we went out to find the ground about us white with hoar frost; but during the day usually the sun came out warm and bright, tempering the sharpness of the east wind.

15. Beyond this point we found ourselves in the land of pines, rhododendrons, and oaks. The marsh from Chelam took us through Rahmung, a pretty little village perched on the very edge of an immense precipice, and thence through the grassy valley of the Dimkai up through the village of Tulcheng, and so over a spur of Dilklang down to the valley of the Tuitan; here a tolerably wide stream flowing through a flat alluvial valley; the path crossed and re-crossed this stream several times for about five miles, when it commenced to climb the high hill of Murklang, crossing it nearly at its highest point at an elevation of 6,858 feet. The eastern face is very steep and precipitous throughout; the path by Enjow's village runs along the edge of a rocky precipice, clothed here and there with trees and grass, with a sheer descent of some thousand feet. Beneath nestles a small village, and beyond is a broad and smiling valley, through which far below, like a silver thread, the Thao winds its way. The beauty of the scene was heightened by the rhododendrons, which clothed the hill sides on each side of our path, and which were in their full glory of rich crimson blossoms, and by the tall pines which shed their sweet fragrance on our path as we descended the valley of "Chumfai."

16. This is the largest valley we saw, and is about five miles in length, and has an average width of about a mile; it has an elevation of 5,000 feet, and the hills immediately surrounding it rise to a height of about 1,200 feet above it. This valley seems once to have been a lake, and the process by which it has filled up seems to be described by Captain Pemberton in 1835 as that going on in the case of the Logtak lake in the following words:—"The bed has begun very perceptibly to fill up from the deposits of silt from the surrounding heights, which are continually carried into it, and, if this progress continues, a few years will suffice to obliterate the lake." Major McCulloch says—"Since 1835 the lake has very visibly filled up. There runs in the lake a range of low hills, the portions of which not covered with water form islands." These words might have been written of the "Chumfai" valley, which is still swampy in places, and the surface of which is dotted over with low hills covered with leafy trees, now apparently isolated, but which evidently at one time were the peaks of a low range similar to that existing in the Logtak lake. A small stream meanders through the Chumfai valley.

17. From Chumhim, and the heights west and south of the valley, a good view is obtained of the surrounding country; that to the south and west is very difficult to make out, being broken and confused, and not presenting the parallel appearance of the northern ranges; the various peaks of the latter are also very difficult of recognition from these points of view. I am inclined to agree with Mr. Edgar in thinking that the Thao, if not the Koladyne itself, is more likely to be a tributary of that river than of the Irrawaddy, as the higher ranges to the east, as far as I could make out, would prevent the great sweep in that direction which the river must take to reach the Irrawaddy. Mr. Edgar also says—"the Lushais, who know most about that part of the country, state that, in fact, a high range of hills does intervene between the "Thao" and some well-known tributaries of the Irrawaddy."

18. The word "tui" will have been observed to occur frequently in the names of rivers. This word means "water" generally. Mr. Edgar tells us that *Tui-lan* means the "sitting water" in reference to the comparatively level course of that stream. I was unable to find out the meaning of the names of other rivers or streams.

19. At the foot of the hills and low down into the ravines we found usually plenty of water, but on the higher ranges near the tops of the ridges the water-supply was very small, even in the neighbourhood of large villages, as the Lushais do not mind going long distances to fetch it, and, as they seldom bathe, they do not require very much. In endeavouring to improve the water-supply in the neighbourhood of our camps by digging wells, &c., I was much struck by finding near the villages two streams of water, one tolerably clear and bright, with small pools formed here and there, the other nearly stagnant, moving slowly through a mass of rank weeds and putrid soil; in one place this sluggish stream was slightly stockaded on the side furthest from the village. I think this arrangement may be part of their system of sanitation, and account for the absence from their villages and their immediate neighbourhood of those unpleasantness which are so common in all the villages I have seen in the Himalayas and elsewhere. If this is so, the Lushais have discovered the principle so strongly insisted on by advocates of the sewage manure system at home—that sewage floated on to any soil is speedily deprived of any unpleasant odour.

20. Captain Lewin's descriptions of the Lushais on the Chittagong side differ in some particulars from the results of our observations on this side; in most of these differences, however, I find that the descriptions of Kookies, their customs, &c., in Major McCulloch's book on Munipur, and in his quotations from Lieutenant Stewart, apply almost perfectly to the Lushais whom we met. This is accounted for in Mr. Edgar's report, in which he tells us that Lalul, the first chief of whom we knew anything, is said to have come of the same stock as that from which the Howlong and Syloo chiefs are descended; and that he and his descendants have reduced to submission or driven out all the Kookies who occupied the northern hills. Most of the men we met till we arrived in Lalboora's country were, therefore, probably descendants of those Kookies who had been reduced to submission.

21. Perhaps a few extracts from Mr. Baker's report on his route in 1869, a copy of which he has kindly lent me, containing a description of the country through which the column passed, and a few notes on the Lushais, may not be out of place here:

"The Lushais are divided into two large and distinct bodies, who are always more or less at feud. These are the 'Marshai' (or Marsa) and the 'Simshai' (or Simsai), but both are generally known as Lushais. The word 'loo' means head in the Kookie tongue; the tribes may, therefore, call themselves the head clans as compared with the more feeble tribes, or the term may apply to some peculiarity of head-dress among them. On this point I cannot offer an opinion.

"In like manner 'mar' means north, and 'sim' south.

"The country traversed by us from Ritabarie to the banks of the Gootur is altogether hilly. We passed no morasses, and, excepting the forests lying between the Munoo river and the Kamuntah range, and the banks of the Deo, the country was found to be high, dry, and quite free from malaria at this season (*i. e.*, February and March). Small streams were met with at the base of all the higher hills, and occasionally springs on the hill sides not far from the tops of the ridges. Besides many others, we crossed the Munoo, Deo, Pakoon, and Gootur, which may be from 20 to 30 yards wide, and at this season from one to three feet deep, having firm sandy beds easily forded; but in the rainy season they must become extremely deep and rapid streams. On the Kamuntah, the Jumpai, and Hachik we saw the sites of what had been large and flourishing poongies. These are now overgrown mostly with high grass, but there are still some fine trees left, among them a few lemon.

"The climate we found in February and March cooler than in the plains. The timber, bamboo, and cane are fine. In many places, notably the vally of the Langai, the scenery is exceedingly pretty, and may even be called beautiful.

"I should say that the country generally is particularly well suited for plantations of the coffee and hill cotton.

"The principal ranges of hills run due north and south, but between these smaller ranges are innumerable; in fact, the entire country is a jumble of hills. The main features, therefore, are mountain ranges of 1,000 to 2,000 feet in height, at intervals of 10 or 12 miles, trending north and south; of confused lines of hills and spurs running down to the bottom of these intervening spaces; and lastly of deep and narrow streams flowing along the lowest levels from south to north, over sandy and rocky beds, and in very winding courses, often under high and precipitous banks. Having penetrated far south, we crossed the valleys high up, near where the streams flowing northward take their rise, consequently we avoided the morasses met with, where the valleys spread out into what are here called 'haors,' *i. e.*, low grassy plains."

22. I fancy, from this description, that, that part of the country does not differ materially from the country through which we passed in the few marches from Tipai Mukh.

Extract from notes to accompany CAPTAIN BADGLEY'S *Report of the Survey Operations in the Lushai Hills, by* LIEUTENANT E. P. LEACH, R. E., *Assistant Superintendent, Topographical Survey Department.*

Limits of work.

The topography obtained lay between the limits $\frac{24°}{24° 40'}$ north latitude and $\frac{93° 15'}{93°}$ east longitude, comprising an area of upwards of 1,200 square miles.

Nature of country.

The country throughout was covered with dense jungle, and no signs of recent occupation existed, till the Kholel villages were reached. Sites of villages are shown on the published map of Munipur on the low ranges to the east of the Bárák river, but no traces of these were visible. This, however, is easily accounted for.

See genealogical table, Captain Badgley's report.

All were probably "Kookie" habitations; the term "Lushai" being more strictly applicable to a kindred clan that has sprung into a powerful existence within the last three generations.

Blood feuds seem to have existed from time immemorial. The "Kookies" representing the weaker clan were gradually driven further, and further north by the "Lushais," the more powerful forming successive settlements as they went, and finally taking refuge in British territory.

A few deserted tenements were met with at the head of the Tui Bum, probably belonging to the people of Kholee or "Lalhi," and an occasional hut on the high range to the north-west of Tipai Mukh near the Trigonometrical Station L4.

Bamboo and cane jungles usually reached a height of about 2,500 feet, interspersed with heavy timber and trees of a resinous nature.

Above this elevation the forest became more open, the under-growth disappeared, and little difficulty was experienced in reaching the various points.

The India-rubber tree, endless v rieties of the mountain ash, the ilex, and a tree locally termed "Nageysar," yielding an extremely hard red-grained wood, abounded on all these ranges.

Geological formation.

The valleys and bed of the Bárák contained boulders of metamorphic rock, changing in places to conglomerate of a deep red colour, showing unmistakeable signs of the presence of iron. This was more particularly the case on the river midway between Nos. 2 and 3 stations. The hills were of sandstone of similar formation to the undergoing strata of the Khasia Hills, and it is probable that granite also, as these, forms a component part of the higher ranges.

The sandstone was of recent formation, and extreme friable limestone is said to exist in the hills to the south of Munipur, but no traces were met with.

Prominent features.

The most remarkable feature in this portion of the country was that appeared to be viewed from the south a continuous range to the north of Tipai Mukh, running east and west between the Bárák and Sonai rivers, the south face apparently presenting a sheer wall of rock perfectly inaccessible and of uniform height.

On further examination, this range sub-divided itself into a series of spurs, rising one behind the other, and continued on either side of the water-shed to the Bárák and Sonai rivers.

Further to the south at the head of the Tui Bum river, and forming the extremity of the "Parbaclang" range, another precipitous face of red sandstone occurs, from which much valuable information regarding the water-shed between the Bárák (or rather Eerung) and Tipai might have been obtained had time permitted.

A very marked feature further to the south is the northern peak of the range marked in the map "Momrang."

This point, I am told by Mr. Baker, is visible from points along the route followed by his column in 1869, and as it had been accurately fixed, and is equally recognizable from the north and south at considerable distances, will form a valuable auxiliary to future surveys.

Another prominent point is the highest peak of the "Surklang" range, a few miles east of Chepui.

The position of "Far Peak" and "Conical Peak," two points fixed by Major Godwin-Austen's survey, have also been verified for future work south of Munipur.

To the west "peak Z," "Chutterchura" and "Purson Sip" are all well marked points and easy of identification.

The outpost at Bonkong lies comparatively low, but is easily recognized, the hill on which it is placed presenting a precipitous face of white rock visible at a considerable distance.

The only two rivers are the Tipai and Bárák rivers. The former has been traced nearly to its source by the Munipuri contingent under General Nuthall, and, shortly after its junction with the Bárák, assumes the character of a mountain torrent, though probably navigable for small boats at certain seasons as far as Kholel. The latter is a stream of considerable dimensions, upwards of 100 yards in width, and receiving a considerable portion of the drainage of the Munipur hills. The rapids which occur at intervals of three to four miles along its length above Mainadhar render navigation difficult; but these, by deepening channels when the water falls, might easily be surmounted and rendered available for much larger boats than latterly reached Tipai Mukh. The "Eerung," its principal tributary, is described on a route survey of Munipur, made in Captain Pemberton's time, as a stream running "knee deep," and 60 yards wide, at a point some 50 miles from the junction with the Tipai; and the Bárák itself takes its rise in the Naga hills south of "Samuguting."

Communication.

Elephants exist in large numbers all over these hills, and their tracks seem to answer all the purposes of the "Lushai," and are rarely improved upon.

They will invariably be found to take the nearest and easiest route to the high ranges, and may be looked for along the banks of all the small streams. Any attempt to penetrate the thick jungle covering the banks of the large streams, and take a direct line, will usually be found unsuccessful.

A track leaving the main path (which may be followed without difficulty), and descending the hill side almost certain to lead to water, and jungle fowl met with in any number towards evening, are a pretty sure sign that water is not far distant.

Scarcity of water.

Want of water, especially on some of the high ranges, was a source of constant trouble, and necessitated an early halt and additional load upon the coolies in the shape of bamboo "chungas" containing a short supply in case of accidents.

On ridges precipitous on one side, and with a gradual slope on the other, water may be confidently expected somewhere near the summit, but where both sides are steep, nothing short of a long descent is likely to be successful.

Salt springs.

A salt spring or "lick" is occasionally found on some of the small hill streams; but from the numbers of wild animals whose prints are to be seen leading from them in every direction, they are apparently of rare occurrence, and the want of this domestic staple will probably be the medium of all future trade with the Lushai hills.

The salt springs at "Purson Sip" were formerly largely resorted to by the Lushais, and the scene of many an encounter between rival manufacturers.

Climate.

A few remarks upon the climate of South Cachar and the state of the atmosphere at particular seasons may be of value.

During the rains, and up to the end of September, the greater part of the country is under water; the low lying valleys and hills are extremely unhealthy, and even the elephants take refuge on the high ranges.

In October the drying-up process commences, but the jungles are still dangerous, and little can be done by the surveyor till the beginning of November.

During the latter month, heavy fogs clearing of an hour or two before noon are very prevalent; but the country is sufficiently dry to commence work by the middle of the month, and the jungles may be penetrated without risk.

December and January are uniformly fine; the atmosphere clear, and the climate extremely pleasant. During these two months all instrumental work should, if possible, be completed.

Early in February rain may be expected, and the atmosphere becomes hazy, and the distant ranges obscured for days together.

Heavy rain sets in towards the end of March. The heat becomes offensive, and the jungles, abounding as they do with every discription of venomous fly, mosquitoes, and other noxious insects, are hardly tenable.

A few clear days may, however, be obtained after heavy rain before the rivers rise, and the country is otherwise impracticable.

Health of party.

The first two months of the expedition were comparatively healthy. Officers and men alike suffered from bowel complaints, but no casualties occurred till February, when cholera carried of a Khasia cooly and Goorkha khalasie. During this month, the sepoys comprising the guard suffered considerably from fever and had to be constantly relieved. The Khasias, however, were uniformly healthy till their return to Mainadhar, when cholera again made its appearance and more than decimated them.

Extract from the Proceedings of the Government of India in the Department of Agriculture, Revenue, and Commerce,—Nos. $\frac{2}{562 \text{ to } 576}$ *dated 13th September* 1872.

SURVEYS.

Read—

A letter (with enclosures) from the Surveyor General of India, No. 160 F, dated 22nd June 1872, submitting reports on the professional results obtained by the above-mentioned survey parties.

RESOLUTION.—The Governor General in Council has read with much interest the report of the Surveyor General of India, with its accompanying papers, on the geographical results obtained by the two survey parties attached respectively to the right and left columns of the expeditionary force despatched into the Lushai hills in the cold weather of 1871-72.

2. Starting each from an assured base, these two parties have, in the space of one short season, topographically delineated 6,500 square miles of new, difficult, and hostile country, and contributed most materially to fill up the gap which had hitherto separated the survey of Chittagong from that of Cachar.

3. The Southern party under Major J. Macdonald, pushing north from Chittagong, succeeded in completing a triangulation of 2,300, and topographical mapping of 1,700 square miles, connected with the eastern frontier series of the Great Trigonometrical Survey. The tract thus explored lies between 22° 30′ and 23° 45′ north latitude and 92° 30′ and 93° east longitude, and its survey has determined a considerable extent of the water-shed between the Cachar and Chittagong, and Akyab water system. Forty well defined geographical points have been established, and the heights of 37 of these obtained with mathematical accuracy.

4. Captain Badgley, in charge of the northern party, started from Cachar, making connexion with a good base belonging to the secondary triangulation of the Great Trigonometrical Survey, and accomplished about 600 square miles of triangulation, with nearly 200 linear miles of route survey, and 4,800 square miles of topography. The region thus surveyed extends to 93° 30′ east longitude and nearly to 23° north latitude, and includes the whole course of the Tui-Vi and its tributaries, which pour their waters into the Bárák at Tipai Mukh. The labours of this party have also contributed to fix a portion of the water-shed between the affluents of the Bárák and those of the Koladan.

5. The reports of the various officers contain also much intersting information as to the physical aspect of the country surveyed, and the manners and customs of the inhabitants, while both these points are still further illustrated by the spirited sketches of Lieutenant Leach and Woodthorpe attached to the northern party.

6. Military considerations did not permit of a junction being made between the two parties, nor was the party under Major Macdonald able to push far enough north to determine the upper course of the Dhaleswari and the Sonai, more westerly affluents of the Bárák. Hence there still remains a blank in longitude, between those portions of the two surveys which overlap in latitude, as also a gap in latitude between the northern limit of the tract surveyed by the Chittagong party and the southern boundary of surveyed Cachar.

7. But the thanks of the Government of India are due for the valuable work accomplished in the face of many difficulties and hardships, and the Governor General in Council desires cordially to acknowledge the services of the officers named in the margin, who, under the able control of the Surveyor General, have contributed such valuable materials towards the knowledge of what has hitherto been an unknown country.

Major J. Macdonald, Offg. Depy. Surveyor General in charge.
Capt. W. F. Badgley, Depy. Superintendent.
„ H. B. Tanner, Depy. Superintendent.
Lieut. R. G. Woodthorpe, R. E., Asst. Superintendent.
„ E. P. Leach, R. E., Asst. Superintendent.
Mr. C. Barret, Asst. Superintendent.
„ G. Cook, Asst. Superintendent.
„ J. Ogle, Asst. Surveyor.
„ W. Robert „ „
„ J. McCay „ „

No. 34.

INDIA OFFICE, LONDON,
Dated 28th November 1872.

To

HIS EXCELLENCY THE RIGHT HON'BLE THE GOVERNOR
GENERAL OF INDIA IN COUNCIL.

MY LORD,

I have received and considered in Council your Excellency's despatch, dated September 9th, No. 23 ($\frac{\text{Geographical}}{\text{Surveys}}$) 1872, and the accompanying reports on the survey operations in connection with the Lushai Expeditionary Force on the Eastern Frontier in 1871-72.

Geographical.

2. The two parties attached to the right and left columns of the Expeditionary Force, under Major Macdonald and Captain Badgley, have executed valuable surveys of a previously unknown country in the face of considerable difficulties. Their work overlaps as regards latitude, and it is unfortunate that circumstances rendered it impossible to connect the two ends of the surveys, and so fill up the longitudinal gap. Nevertheless much good work has been done, and the fresh material will enable the Surveyor General to compile a map of the Eastern Frontier, which will be very much more complete than any that have preceded it. I have pleasure in expressing my concurrence in the opinion expressed by your government of the value of the services performed by the surveying officers.

I have &c.,
(Signed) ARGYLL.

APPENDIX B.

RETURN to an order of the Financial Department of the Government of India for the information of the* INDIAN FINANCE COMMITTEE OF THE HOUSE OF COMMONS, *as to the Surveys carried on under the Government of India for the season* 1870-71, *the work performed and the cost thereof, corresponding with the actual expense shown in the budget estimates for that year.* BY COLONEL H. L. THUILLIER, C. S. I., F. R. S. *&c., Surveyor General of India.*

* No. 3494, dated 27th October, with despatch No. 323, dated 22nd August 1872, of Secretary of State.

1. The imperial survey carried on under the Government of India is of three kinds.—

Trigonometrical, for the accurate fixing of all important places and showing the latitudes, longitudes and heights above the mean sea level, of such a number of obligatory and other points as to form a complete basis for the connection and starting of all other surveys.

Topographical, on a Trigonometrical basis by breaking up the principal triangles obtained with the larger instruments into secondary and tertiary triangles, by means of which the topography is depicted by plane table sketching on a minor scale.

Revenue or Fiscal, which is likewise a good topographical survey on a larger scale with the depiction of the boundary of every village or parish, as well as of districts and other sub-divisions in the revenue-paying champaign provinces.

2. The following is a general outline of the several heads of account of the expenditure incurred, and of the system prevailing, in a succinct and brief form, on the supposition that no previous acquaintance with the Indian system prevails, and has been prepared under the extreme haste with which the information has been called for. The allotted budget estimates for the entire department amount in round numbers to £240,000 distributed as per margin.

	£
Trigonometrical	70,000
Topographical	70,000
Revenue	100,000
TOTAL ...	240,000

3. The Great Trigonometrical survey is under special management, and the general operations are fully described in the chart of triangulation published with the annual administrative report of that branch of the department, showing precisely to what extent the Great Triangulation has passed over the whole of India and what blanks remain to be filled up.

4. The several field, or executive parties as per margin† were at work in the season referred to for which the full details and the various particulars and cost of the operations will be found in the abstract report, dated the 19th December, now rendered by the Superintendent of this branch, Colonel Walker, R. E., and in his printed annual administration report for this season 1870-71.‡

† 6 Skeleton Principal Triangulation.
3 Topographical.
2 Astronomical.
1 Leveling.
1 Pendulum.
13 Total

‡ Dated the 1st December 1871.

5. The Topographical Surveys or representation of the Native States, or hilly British non-regulation territory, on the minor scale of one inch per mile, progress at the rate of about 16,000 to 20,000 square miles per annum, by the agency of seven distinct executive parties (one being in abeyance during the season referred to for want of funds) as specified in the margin.

No. 1. Originally raised for Jhelum and Rawul Pindi survey, and from which all the topographers were raised and transferred to other parties now employed in Gwalior or Scindhia's territory, from the Chumbul to the Nerbudda, east of meridian 76°.

No. 2. Established in 1855-56, the old Hydrabad party. In abeyance.

No. 3. The old Madras party, brought up from Ganjam, Goomsur, &c., for the Orissa Tributary States in 1854-55. Now employed in the Madras Subsidiary States or Agencies extending from Ganjam parallel with the Coromandel Coast, through the Vizagapatam Agency, Jeypur and other petty States recently transferred to the Central Provinces.

No. 4. Emanated from No. 3 party to work northward so as to cope with the immense area required to be done in this

6. During this season 14,592 square miles of survey were effected at an actual cost of Rs. 3,45,242. The survey is effected entirely on a trigonometrical basis, the Great Triangles being broken up into minor triangles of convenient small sides, suitable for sketching the features of the country by plane table, which is sufficient for general military purposes, and for filling up the Atlas of India, by reduction from the 1 inch to the $\frac{1}{4}$ inch scale, and is as large as a first delineation, of such rugged and unprofitable ground, paying no revenue to Government warrants.

direction. Lately employed in the Chota Nagpur Province or Commissionership now extended to the north-east portion of the Central Provinces in Mandla, Belaspur, &c.

No. 5. Raised in 1862-63 for the Rewah or Baghelkund, Bundelkund Native States, both of which have been completed. Bhopal, north of Nerbudda and south of the assumed limits of the Gwalior survey, now in progress.

No. 6. Raised in 1863-64 for the Garo, Khasia and Naga Hills, Eastern Frontier, south of the Assam valley and north of the districts of Mymensing, Sylhet, and Cachar.

No. 7. Expanded from No. 1 party in 1864-65. The Rajputana Native States Agency west of the meridian of 76° and between the parallels of 25° and 30° embracing Odeypur, Jodhpur, Jesulmeer, Bikaneer, &c.

7. The mean average cost per square mile of this description of survey, comes to about Rs 22. or £2.4s. The average for the season 1870-71 was Rs. 23-3.

8. The equipment, training constitution and procedure of these topographical parties is especial and totally different to that of other survey establishments required for revenue, or minute land measurements, on a large scale. One system and one scale of survey for all India is not applicable or practicable, and therefore the machinary is adapted to the particular wants and necessities of so vast an empire, so as to deal with champaign rich revenue-paying districts, as well as, hilly, rugged, and unprofitable countries, in a way suitable to each.

9. The nature of, and the reasons for, the expense incurred, on account of the topographical surveys, will be understood from the following analysis of the actual outlay for a single season.

EXECUTIVE DEPARTMENT, OR FIELD ESTABLISHMENTS.

		Rs.
Salaries of 13 Deputy and Assistant Superintendents, including military pay and allowances		1,02,076
Salaries of 42 Surveyors and Assistant Surveyors and of Native establishments for survey parties		1,60,586
Travelling allowances to officers	7,420	38,494
" " to establishments	31,074	
Special Local allowances for exceptionally dear localities to officers	223	11,525
Local allowances to establishments	11,302	

CONTINGENCIES.

Purchase of stores, tents, &c.,	1,232	
Rent of offices for each party or division survey	3,318	
Feed and keep of elephants	4,399	32,561
Postage charges	646	
Miscellaneous, line clearing, &c., &c.	22,966	
Total Topographical Surveys, Rs....		3,45,242

10. There is an immense area remaining to be effected on the 1-inch scale by these topographical parties of all the portions of the Native States not yet taken up, but urgently required for military, geographical, and other purposes. Each existing party has at least from 10 to 15 years work before it, and possibly more. The annual printed report by the Surveyor General for this season, dated 15th January 1872, enters fully into more minute details connected with the work in question, its nature, precise locality, and cost, and may be referred to if required.

General summary of topographical surveys accomplished.

11. The topographical operations divided into provinces and Native States, may be summed up as follows: as to what has been already done; what remains to be done; with a rough approximate estimate of the time required to finish present projects. But there is no fixity to the wants and requirements of India as its resources become better developed; the estimate cannot, therefore, be entirely depended upon.

See Markham's Memoir on the Indian Surveys, 1871.

12. Orissa Tributary States, by No. 3 Party, under Colonel Saxton:—

BENGAL PROPER	Completed.	Remaining.
Or Lower Provinces under the jurisdiction of the Lieutenant-Governor of Bengal.	16,184 Sq. miles.	*Nil.*

Chota Nagpur, by No. 4 Party, under Major Depree.

28,636 Sq. miles. *Nil.*

Khasia, Garo and Naga Hills, by No. 6 Party, under Major Godwin Austen:—

Completed. Sq. miles.	Remaining. Sq. miles.	Likely to occupy.
11,333	23,674	7 years.

NORTH-WESTERN PROVINCES.

13. None executed in these provinces under this branch of the Department. The Himalaya Survey, extending from Kashmir and Ladak to the Nipal Frontier, now in progress in Kumaon and Gurhwal, is conducted by a party of the Great Trigonometrical Survey, and is fully described in the separate report of that branch in conjunction with the Geodesical operations.

PUNJAB.

14. *Hazara.*—The first survey of this district was a military reconnoisance only, but based on the Great Triangulation. It has since been resurveyed topographically by Lieutenant-Colonel H. C. Johnstone of the Revenue Branch, on special demand. Area completed. 750 square miles.

Kohistan, Sind, Sagur, Dooab.

15. This embraces the Districts of Jhelum and Rawul Pindi with portions of Hazara, Shahpur, and Bunnoo, and the salt range, admirably surveyed by Captain D. G. Robinson, R. E., on the 1-inch scale, from 1851 to 1859.

Area completed. Sq. miles.	Cost Rs.
10,555	2,14,538

Protected Hill States, Simla, and surrounding country.

16. These were the first portions of the Himalayas topographically surveyed by the officers of the Great Trigonometrical Branch. The scale was only ½-inch to the mile. Kashmir and Jamu, the territory of the Maharaja Runbhir Sing, was also accomplished by the same Branch of the Department, and will be accounted for in the Trigonometrical Report. The rest of the Punjab Province, all champaign and revenue-paying districts, has been well surveyed by the Revenue Branch of the Department on the 4-inch scale, in close connection with the Great Triangulation.

CENTRAL PROVINCES.

17. The Sathpura range of mountains, comprising portions of Hoshungabad, Baitool, Chindwara, and Nursingpur Districts, have been topographically delineated by the Party No. 2, now in abeyance, which effected the survey of the Berars and part of the Nizam's (Hydrabad) dominions.

Completed. Sq. miles.	Remaining.
7,020	*Nil.*

Mandla, Belaspur, Balaghat, &c., by No. 4 Party, under Major Depree.

Completed.	Remaining. Sq. miles.	Likely to occupy.
Nil.	17,723	9 years.

Sumbulpur, Ryepur, Bustar, &c., by No. 3 Party under Colonel Saxton.

Completed.	Remaining.	Likely to occupy.
42,876	6,138	6 years.

Native States much intermixed.

Rajputana and Central India Political Agencies, by Nos. 1, 5 and 7 Parties under Lieutenant Charles Strahan, Captain Riddell, and Captain George Strahan, R. E.

Completed.	Remaining.	Likely to occupy.
68,697	1,40,106	20 years, with three Parties.

Bundelkund or Bundela States, as well as Baghelkund or Rewah, have been completed and are included in the above area of 68,697. The area here remaining to be accomplished embraces Bhopal and Malwa, as well as the rest of Rajputana and Scindhia's territories, &c.

MADRAS.

18. *No. 3 Party.*—This party, under Colonel Saxton, has done a large area in the hilly mallias of the Ganjam and Vizagapatam Agencies. It has still much to do in Jeypur and other States of the above Agencies, as also in Bustar and other adjoining Native States of the eastern portion of the Central Provinces.

Ganjam and Vizagapatam Agencies.

Completed.	Remaining.
10,048	5,196

19. The topographical survey of this State was commenced by the Madras Survey officers many years ago; and, after a considerable suspension in the operations caused by various untoward circumstances, the entire jurisdiction was completed after a period of about 50 years from the date of its first commencement by the Party No. 2 under the late Mr. Mulheran, Deputy Superintendent. The Assigned Districts (Berar) were also included in this field of survey.

Nizam's Dominion, Hydrabad, Deccan.

Completed. Sq. miles	Remaining.
97,137	*Nil.*

20. The above is all that has been done by the present system of topographical surveys in the Madras Presidency, but the officers of the old Military Institution acted as the pioneers of survey, early in the present century, in delineating the Southern Peninsula on the 1-inch scale, from which the existing sheets of the Indian Atlas have been published. A new revenue cadastral survey of the whole of the Madras districts has been in progress for the last 15 years under separate superintendence in that presidency, but no new geographical results have been furnished therefrom up to date. The imperative necessity of utilising some of the revenue surveys for geographical purposes has been strongly insisted on.

BRITISH BURMAH.

21. A topographical survey on the small scale of ½-inch to the mile, which may be more fairly termed a close reconnoissance, has been made of the Pegu Division of British Burmah under the local administration, and independent of this Department, on an independent basis prior to the extension of the Great Triangulation in this direction. The area completed and mapped on the above scale is 32,250 square miles, the general map of which in four sheets has been lithographed in this office. It is probable that an entirely new survey, conducted on rigorous principles and based on the Great Triangulation, partially carried in this direction, will be necessary for the Pegu and Martaban Division, as well as of the whole of the Tenasserim Provinces, never yet surveyed.

22. The total area of the Bombay Presidency, including Native States, is 1,91,948 square miles; of this, the areas specified marginally have either been surveyed* or are under survey,† leaving about 72,552 remaining for survey, of which about 50,000 square miles are applicable for topographical delineation, and the remainder will require more minute revenue survey. The above figures are very approximate, as the results of the Bombay revenue measurements are altogether unknown; and how far any of the work may be susceptible of incorporation with the ordinary topographical maps for the purposes of geography and the atlas of India, it is impossible to say.

BOMBAY.	Sq. miles.
Konkan	39,000*
Sindh	58,782*
Kattywar	19,850†
Cutch	6,764†

Remaining to be completed.	Likely to occupy.
50,000	25 years for a single party.

But with additional working power the time may be decreased in proportion.

23. For the last 30 or 40 years no geographical contributions whatever have been made from the Bombay Presidency towards the filling up of the sheets of the atlas, which are peculiarly blank throughout the Northern Division of the Presidency, but great exertions have lately been made by this Department to alter this state of things, and to obtain proper agency for regular topographical surveys of the blank portions. There are now five regular parties belonging to the Imperial Survey Department employed in that Presidency as per margin.

Gt. Trigonl. Branch,	Kattywar.
	Guzerat.
Topographical do.	Kandeish.
Revenue.	Nasik.
	Ahmednuggur.

24. Up to the past season a general area of both topographical and revenue surveys combined, the areas as per margin, have been accomplished and are still remaining to be dealt with in Bengal and Bombay Presidencies, which, with existing agency and allowed financial means, may possibly occupy about 20 years in the execution, but fresh wants for new surveys and on larger scales are springing up constantly, and what sufficed 30 or 40 years ago does not come up to the expectations or wants of the present day for engineering and other purposes. Consequently the first survey of India, which is so urgently needed for all purposes of administration, and which is so moderate in its mean average cost per square mile, which may be taken at £2 11s. will, no doubt, when completed, have to give place to some extent to a more minute and superior style of survey on improved scales and executed at a higher cost.

General combined topographical and revenue survey results.

Completed.	Remaining.
634,739	Sq. miles 251,243 Top.
	211,356 Rev.
Total.	Sq miles 462,599

25. By the joint efforts of the several branches of the Imperial Survey of India an area of 35,000 to 40,000 square miles is annually effected, mapped, and for the most part published, in a preliminary style within the same period. The progress and outturn of course depends much on many local causes, over which the executives have but little control.

REVENUE OR FISCAL SURVEYS.

Punjab and Bhawulpur	3½
North-Western Provinces	1½
Oudh	1
Upper Circle, Total ...	6
Central Provinces	3
Lower Provinces, Bengal	4½
Lower Circle, Total ...	7½
Total Parties	13½

26. Since the reduction of the Department on financial grounds in 1870, there are the marginally noted revenue survey parties at work in the several local jurisdictions under the immediate superintendence of two Deputies, controlled generally by the Surveyor General, employed on a sort of tithe commutation survey, village by village, in the rich British champaign districts, on the scale of 4 inches = 1 mile. The unit of the survey is the village, and from the boundaries thus defined, every local jurisdiction of the civil and criminal limits can be laid down by following the cluster of villages forming each circle of police or revenue collection.

27. The positions of the current surveys and the precise field of employment for each party is given in the margin. The budget allotment for these fiscal surveys is £100,000 per annum, and this maximum is approached as near as possible with work of such peculiar and diversified character, influenced as it is by so many circumstances of localities affecting life and

Jurisdiction.	Districts.
Punjab.	Derajat.
	Delhi Division.
	Bhawulpur.

N. W. Provinces	Moradabad. Bareilly.
Oudh.	Gonda.
Central Provinces.	Chindwarra. Ryepur. Chanda.
Lower Provinces, Bengal	Luckimpur. Nowgong. Seebsagur. Hazaribag. Hoogly. (Assam.)

health, and where the period of maintaining the full working strength varies so greatly both from physical and local causes.

28. The mean average cost of effecting this description of work is about Rs. 45 or £4 10s. per square mile. The average area surveyed annually by a full and complete revenue party is from 1,000 to 1,200 square miles on the traverse system of land survey by theodolite and chain periphery measurements of boundaries of villages and estates, all perfectly identified and susceptible of incorporation with the Great Triangulation, forming a complete topographical delineation of the country, useful alike for fiscal and for geographical purposes.

29. The village system or definition of revenue boundaries and ascertainment of areas forms again the basis for the more minute record of the measurement of "fields" on a scale four times larger, or an approach to the cadastral system, for the record of every holding, which has heretofore been conducted, according to the primitive native system, of measuring land in conformity with the knowledge and experience of the native landowners and cultivators of the soil, with and on which operation, checked and confined by the professional or English survey, the settlements with the people have heretofore been conducted. This rough and antiquated process by native agency, and according to native ideas and system only, it is now in contemplation to exchange for the more reliable and correct method of a regular cadastral survey on an adequate scale like that of the Ordnance survey of Great Britain on the 25 inch = 1 mile scale, which, it is believed, will be found more worthy and reliable as a basis for the revenue assessment and Government demand of an empire depending so entirely almost on its land revenue.

30. There is still much remaining to be accomplished by this description of survey, *viz.*, the greater portion of the North-Western Provinces, a proper resurvey of which has only recently been commenced, to supply the loss caused by the mutiny, and in order to meet the requirements of a new settlement. The Dehli Division west of Jumna River, transferred to the Punjab, together with the Derajat west of the Indus up to British Frontier, now ripe for revenue or fiscal investigation. Also a few remaining districts in the Central Provinces, as well as some in Assam of the Lower Provinces. The above will occupy existing establishments many years. The total expenditure for this Branch of the Department for the season under report amounts to Rs. 8,89,433, including the Revenue Administrative Office.

31. With the above general explanation of the nature of, and the reasons for, the expenditure on account of the revenue or fiscal surveys of this side of India, as conducted under the Imperial Government, further details as to progress and cost with the budget actual expenditure will be found in the annexed report of the Superintendents of that Branch of the Departments, dated 21st December 1872, Appendix A.

Administrative Offices, Surveyor General's Department.

32. The Administrative Branch of the Department consists of the following establishments at Head-Quarters, Calcutta, under the immediate direction of the Surveyor General, aided by three Assistants Surveyor General.

ADMINISTRATIVE DEPARTMENT.

	Rs.	Rs.
1. Administrative Officers, including correspondence office		32,500
2. DRAWING BRANCH.		
Compiling and drawing of maps, plans, charts, &c.	53,922	
Travelling of Field Office while on tour	4,969	
CONTINGENCIES.		
Rent of offices, postage charges, service telegrams, presidency house-rent of upgraded assistants, miscellaneous, &c.	20,112	
Total Surveyor General's Office, Rs. ...		1,61,403
3. ENGRAVING BRANCH.		
ESTABLISHMENT.		
European engravers and plate printer, Native engravers and apprentices, writer, Native printers, pressmen, servants, &c.	29,406	
CONTINGENCIES.		
Presidency house-rent for European establishment, repairing tools, machinery, &c., purchase of chemicals, office furniture, &c., and miscellaneous ...	4,879	
Total Engraving Branch, Rs.		34,284.

4. PUBLIC OBSERVATORY.

ESTABLISHMENT.

Superintendent, computers, observers and servants	6,029	
CONTINGENCIES.		
Miscellaneous	255	
Total Public Observatory, Rs.		6,284

5. LITHOGRAPHIC BRANCH.

ESTABLISHMENT.

Superintendent and chief draftsman, chromo-printer, draftsmen, writers, Native printers, pressmen, servants, &c.	27,774	
CONTINGENCIES.		
Purchase of type-printing materials, presses, &c., rent of office, purchase of oils, chemicals, ink, &c., repair of furniture, packing charges and miscellaneous	5,727	
Total Lithographic Branch, Rs.		33,501

6. PHOTOGRAPHIC BRANCH.

ESTABLISHMENT.

Photographers, zincographers, printers, pressmen, servants, &c.	18,096	
CONTINGENCIES.		
Cost of photographic chemicals, rent of office, purchase and repair of racks, shelves, presses, &c., and miscellaneous	10,734	
Total Photographic Branch, Rs.		28,830

7. MATHEMATICAL INSTRUMENT MANUFACTORY.

Salary of Officiating Superintendent and office establishment	5,216	
MANUFACTORY ESTABLISHMENT.		
Instrument-maker and assistant, mechanics and laborers	21,584	
STORE ESTABLISHMENT.		
Store-keeper, clerks and others	2,280	
CONTINGENCIES.		
Purchase of tools, stores and materials for work-shops, purchase of new and second-hand instruments, rent of office and miscellaneous	22,434	
Total Mathematical Instrument Manufactory, Rs.		51,514
Total administrative offices		3,15,816
Total Executive Field Establishments		3,45,242
Grand Total Topographical Surveys, and Surveyor General's Department, Rs.		6,61,058

33. The specific purposes for which these several establishments are required are as follows—No. 1 is for the conduct of the general business, correspondence and accounts, entailed by the control and supervision of the department,—the custody and maintenance of the records,—the issue of published maps, and various miscellaneous duties. It is the geographical depôt for the whole of India.

Clerical Office.

34. No. 2 is for the geographical business connected with the examination, compilation, drawing, and reduction of maps on all scales, as rendered by the executives, and geographical materials derived thereon, preparatory to publication,—for the revision of the proofs from the several printing presses—and the construction of the sheets of the Atlas of India, in manuscript, to be put into the engravers hands, as well as the coloring of all printed maps and meeting the wants of the several local Governments. This branch is under the immediate superintendence of J. O. N. James, Esq., Assistant Surveyor General, a Departmental Officer of great experience.

Geographical Drawing and Compiling Branch.

In 1870-71 *the work completed was as follows*:—

General maps and extensive compilations on various scales	14
Quarter sheets of the Indian Atlas, 4 miles = 1 inch	32
Sheet maps of old topographical surveys, 1 inch scale, redrawn for photozincography	29
Miscellaneous maps, charts, and extracts	20
Maps colored, corrected, &c.	23,321

35. No. 3 is for the copper plate engraving of the final results of the survey on the sheets of the Indian Atlas, as well as other provincial and miscellaneous maps on various scales, as only very

Copper plate Engraving.

lately established in India and transferred from the geographer to the Secretary of State at the India Office. The European staff sent out from England is now training the Native agency largely. Great advantages have already resulted from the conduct of this most important part of the work, so intimately connected with the survey of India, under proper professional supervision and instruction at the head-quarters of the Department in India. This work in India commenced with a staff as per margin, and has been very recently increased by a small number of Europeans and a considerable addition of native apprentices, who prove apt scholars, and will in time form a valuable class, capable of executing first class engraving.

European	Hill Etchers ...	2
Do.	Outline, writing, and ornamentation ...	4
Native	Hill Etchers ...	2
Do.	Writing and outline ...	2
Do.	Apprentices ...	4
	Total ...	12

Observatory.

36. No. 4 is for the purpose of showing mean time to the Shipping of Calcutta, by observation of the sun's transit at noon, and dropping of the mean time Ball for rating chronometers, as well as for taking meteorological observations hourly, day and night, the results of which are published monthly in abstract form and weekly in the Government Gazette.

Lithographic Press.

37. No. 5 is for copying and printing maps for each branch of the Department by the lithographic process, and issue for all subjects requiring revision and recopying, and which are not adapted for reproduction by the photographic process. It is also necessary for the speedy publication of the maps on both the 1 inch and $\frac{1}{4}$ inch scales, urgently demanded by all local officers, as preliminary productions before the engraving of the latter can be executed. All general and useful maps of Provinces or Districts are treated in this manner. An average of 100,000 copies of maps of various sorts are struck off annually by this process. The details of work produced in this branch of my office are given in a report by Captain W. G. Murray, Assistant Surveyor General in immediate charge.

Appendix B.

Photographic Department.

38. No. 6 is of modern adoption and enables us now to produce all the results of the current surveys, prepared expressly for this object rapidly and effectively, which before were never printed or published in any form prior to the engraving on the small scale. By a combination of system in the preparation of the manuscript maps, they are now susceptible of immediate photographic reproduction and transfers to zinc without any hand-copying at all, and the public service is immensely benefited thereby. The perfection to which this art is now brought, and the great facility with which the transfers are effected, owing materially to the beauty of the original drawings, but also in a measure to superior manipulation of the process, has proved of immense value to the Department and to all administrative officers interested in getting the results of good surveys for all local purposes. About 100,000 copies of maps are now turned out by this process alone annually.

Appendix C.
See also Captain Waterhouse's excellent work on the "Cartographic applications of photography," published in 1870.

39. The general results achieved in this branch of my office, with the details of expenditure, are well described in the separate report appended by Captain Waterhouse, Assistant Surveyor General.

Mathematical Instrument Workshops and Depôt.

40. No. 7, under the immediate superintendence of the Deputy Surveyor General, this establishment is a valuable adjunct to the Survey Department for the repair of all the instruments in use, as well as for the manufacture of many of the simpler instruments and implements required for survey purposes, and which can be made better in this country. It also forms a depôt for the safe custody of all the instruments sent out from England on indent, from which all the supplies are drawn by executives under due control by Heads of Departments. It is likewise largely made use of by the Public Works Department and other branches of the Public Service, both Military and Civil. The details of work performed and cost of the same are fully accounted for in the separate report by the Officiating Superintendent of that Department annexed.

Appendix D.

Cartography.

41. The administrative printed annual reports fully show in what manner and to what extent the results of all the surveys are put to proper account and treated by the several processes of photo-zincography for the immediate reproduction and issue of the standard sheets of both topographical for Native States and revenue surveys for British Districts and Provinces. Also by lithography for those older materials, all colored and not adapted for photography, but which form admirable avant couriers, as preliminary productions, to satisfy the reasonable and pressing demands of local administrative officers, and again by engraving for the final reduced maps for incorporation in the great atlas of India.

42. The great object is to supply every local officer and administration with some sort of printed results of the surveys, and no time is lost in the Surveyor General's Department in producing the maps as called for, either as preliminary or temporary issues by either of the

two former processes, according to the capability of the establishments, as well as in taking the final step of engraving for all the really disposable surveys which are ready in every way for that treatment. As shown above, 200,000 impressions of maps are turned out annually, independent of the atlas sheets, the preparation and issue of which have up to the present time been lamentably slow from various conflicting causes unconnected with the administration of the Survey Department in this country.

43. The above extensive issues showing an immense increase over former years, before the introduction of the photozincographic or carbon transfer process, may be said to be remarkable.

44. Every effort has been made for some years past to deal with the enormous outturn of all the surveys on this side of India, and great success with small means has been achieved. All the published maps are now regularly sent to the India Office for inspection at the new Geographical Department there, and for sale through London agents. There is no part of the executive field of our operations which is not published in some form or other for distribution to officials and sale to the public.

The London Agents are Messrs. W. H. Allen & Co., Waterloo Place.
Mr. Stanford, Charing Cross.

45. The general results of the utilisation of the survey materials, and their final embodiment into the Atlas of India, are given with much detail in my two printed special reports, cited marginally, showing the precise sheets already published, both full and only partially complete; those in course of engraving both in England and in India; those for which surveys were partially available, and the entire blanks, as well as regarding the nature and extent of the materials available towards the preparation of a complete Map of all India, and the filling up of the remaining sheets of the atlas now blank.

State of this Atlas of India on the scale of 4-inch=1 mile.

No. 188F, dated 13th June 1871.
No. 808F, dated 28th October 1871.

46. Of the total number of sheets composing the Atlas, according to the published index map, the numbers of those already engraved in hand or remaining are abstracted marginally. Much has been done of late years, but very much still remains to be done, and of that already published much is now obsolete and will be superceded by better surveys, and require fresh editions of the sheets to be engraved.

Complete full sheets	... ...	40
Do. quarter sheets	... ...	13
Incomplete sheets (published)	...	48
Entirely blank unpublished sheets	...	28
Extra sheets belonging to Martaban and Tenasserim, all blank yet	... ...	11

47. The last printed catalogue of maps published and available at the Surveyor General's Office, gives the best idea of what is done with the survey materials. The Government Gazettes likewise notify the outturn of our several printing establishments monthly. Agents are appointed in several large stations for the dissemination and sale of all available maps, to which very moderate prices are affixed, and the object is to afford every possible facility to the public to obtain any and all of our publications.

48. In like manner a catalogue has been published of the maps available at the Geographical Department at the India Office, which affords further facilities to persons in England desirous of procuring any of the maps of the Indian Surveys.

SURVEYOR GENERAL'S OFFICE,
Calcutta, the 24th December 1872.

H. L. THUILLIER, *Colonel,*
Surveyor General of India.

APPENDIX C.

COMPILING, DRAWING AND GEOGRAPHICAL EXAMINING BRANCH, SURVEYOR GENERAL'S OFFICE.

STATEMENT showing the nature of the work performed and the progress made from 1st January to 31st December 1872.

Maps, &c.,	Scale.	Progress and Remarks.
	Miles. Inch.	
India.—Standard Map in 6 sheets. ... Sheet 3, Central India, Rajputana, Sindh, &c.,	32=1	Portions of Sindh, Rajputana States and Districts in the Central Provinces added. Laid aside for compilation of Atlas Sheets.
Sheet 4, Nepal, Bhutan, Bengal and part of the Central Provinces, &c.,	Ditto	Portions of Joypur and Bustar added. Awaiting further materials from surveys in progress.
India.—Reduced from the above Standard Map, in 4 Sheet.	64=1	Inked in outline, rivers and roads; names of chief Towns, Civil and Military Stations written out lines engraving.
India.—For a General Map of the world; Estern Punjab Section; Latitude 30° to 35° Longitude 74° to 98°.,	10=1	Portions of districts Amballa, Loodianah, Hushiarpur and of the protected hill states compiled and partly inked. Laid aside for the compilation of Atlas Sheets.
India.—No. 2, (Hand Maps) 3rd edition ...	128=1	Hills being drawn for engraving in progress.
Bengal.—Jurisdiction of the Lieutenant-Governor, Standard Map in outline in four Sections.	16=1	Completed in outline; names written, Assam added from the best available sources; Map Photozincographed.
Bengal, Behar and Orissa.—2nd edition ...	32=1	Various additions and corrections.
Chota Nagpur Division.—S. W. Frontier of Bengal; Office copy General compilation.	4=1	Survey results 1879-70-71, added; Hill shading in progress.
North-West Provinces and Oudh.—Outline Map	32=1	Various additions and corrections. Map published for administration reports.
Preliminary Compilation Map of the Garo Hills.	4=1	Compiled in outline as far as Survey results were available; awaiting further Survey.
Hushingabad District.—2nd edition ...	4=1	Revisions and addition of the hills portion from Topographical Survey to complete the district according to its present limits; finished.
Sheets of the Atlas of India.		
Sheets 2, Quarters S. E., S. W., N. E. ...	4=1	Province of Sindh; Quarter S. W., compiled and Hills drawn; N. E., only hills drawn; S. E., hills in progress.
Sheet 9, Quarters N. W., S. E., S. W. ...	Ditto	Province of Sindh; Quarter N. W., completed; S. E completed Hills drawn; S. W. only hills drawn.
Sheets 50, Full plate (old) Proof received from England for additions to complete blank portions.	Ditto	Joypur, Alwar and Kerowli States in the Rajputana Agency; added from recent Topographical Surveys, nearly half the sheet was blank completed and returned to England.
Sheet 52, Quarters S. E. ...	Ditto	Part of Gwalior state, compilation in progress.
Sheet 53, Quarters S. E. ...	Ditto	Parts of Hooshaugabad, Baitool and Chindwara in the Central Provinces. Completed as far as Survey results were available sheet engraving.
Sheet 54, Full plate (old) Proof received from England for additions and completion of blank portions.	Ditto	Fully two-thirds of this large sheet is quite blank; Districts Nimar, Baitool, &c., under compilation in progress.
Sheet 72, Quarters N. E., N. W., S. E. ...	Ditto	Central Provinces, Portions of districts Chindwara, Seoni and Bhandara under compilation.

STATEMENT showing the nature of the work performed and the progress made from 1st January to 31st December 1872,—continued.

Maps, &c.	Scale.	Progress and Remarks.
	Miles. Inch.	
Sheet 73, Full plate (old) ...	4 = 1	Heavy additions necessary to complete the blanks. The greater portion of the Chanda district compiled. Engraving of outlines in progress.
Sheet 89, Full plate (old) Proof received from England for completion of blank portions.	Ditto	Rewah, Southern portion, and some Bundela States added. Heavy additions completed and proof returned.
Sheet 104, Full plate (old) Proof received from England for completion of blanks.	Ditto	Parts of districts Hazaribagh and Lohardugga. Compilation of district Hazaribagh in progress.
Sheet 105, Quarters N. W. and S. E. Proofs received from England for completion of blanks.	Ditto	Gurjat States in the Chota Nagpur Division. Completed and hills drawn; proofs returned to England
Sheet 124, Quarter N. W. ...	Ditto	Assam. Part of district Kamroop and East Dooars completed. Sheet engraving.

N. B.—Except where it is specified in the column of remarks, the hill shading remains to be done on all the above drawings of Atlas Sheets.

Standard sheets of the Topographical Survey re-drawn for Photozincography.

	Miles. Inch.	
Chota Nagpur Division sheets 24, 25, 26, 33, 34 and 43.	1= 1	Projected and re-drawn from the original field sheets.
Sheets 12, 13, 14, 21, 22 and 23... ...	Ditto	In progress in various stages.
Ganjam and Orissa (old series) sheets 2, 3, 4, 5, 6, 10, 16, 17, 18	Ditto	Projected and re-drawn from the original field sheets.
Sheets 7, 8, 9, 11, 19, 35, 36, 37, 59, 60, 84, 86	Ditto	In progress in various stages.
Central Provinces and Vizagapatam Agency (new series) sheets 1 and 4.	Ditto	Additions to complete the sheets for publication in a complete form.
North-East Division, Central Provinces sheets 3	Ditto	Re-drawn from Chota Nagpur Division Survey sheet 62.
Sheet 6	Ditto	Additions to complete the sheets.
Rewah Survey sheets 3, 11, 13 and 15 ...	Ditto	Projected and re-drawn from the original field sheets.
Sheet 10	Ditto	In progress.
Khasia and Garo Hills' sheets Nos. 16 and 17 (in one).	Ditto	A larger portion re-drawn, hill drawn in progress.

Miscellaneous Maps, Charts, Tracing, and Extracts.

	Miles. Inch.	
Map of Bengal	64 = 1	For the Bengal Census Report.
Trans-Indus Frontier, 2 sheets ...	2 = 1	Copied for the Superintendent, Geological Survey.
Survey of the British boundary on the Northern Frontier of Zillah Purneah, North Behar	Ditto	Extract for J. G. Charles Esq.
Skeleton Map of the frontier between Holkar's State and Khandesh ...	Ditto	Fair copy for the Foreign Department.
Tracings of the Salween River in Burmah and of routes between Burmah and China	15 large sheets.	For Mr. Cocyton, Recorder of Moulmein; most of these were rough Burmese maps.
Plan of the cantonment of Sekandrabad ... including the Residency	1 = 4	For the Garrison Instructor.
Extracts from the sheets of No. 3, Ganjam and Orissa Survey, seasons 1852-53 and 1858 to 62.	1 = 1	Tracings of the boundary between the Ganjam Agency and Central Provinces for the Superintendent of Revenue Survey, Madras.

STATEMENT showing the nature of the work performed and the progress made from 1st January to 31st December 1872,—continued.

Maps, &c.	Scales.	Progress and Remarks.
	Miles. Inch.	
Extracts from unpublished Charts of the Great Trigonometrical and Topographical Surveys	4 = 1	Eleven extracts with numerical data added for various departments.
Simmons' plan of Calcutta	... ...	Various additions and corrections to complete the plan up to date 1872.
Corrections and additions to Topographical Survey sheets	1 = 1 2 = 1	Fifty-two sheets examined and corrected.
Corrections and additions to engraved, lithographed, and photozincographed maps ...	Various.	Railways, boundaries, territorial names, &c., inserted on 1,905 sheet maps.
Lithographed and photozincographed maps and plans colored	Ditto.	Thirty thousand, one hundred and sixteen sheets colored.
Atlas sheets and engraved maps colored ...	Ditto.	Four thousand, two hundred and thirty-six sheets colored.
Proofs examined of maps, charts and plans	Ditto.	Four hundred and sixty-six sheets.

Surveyor General's Office,
Calcutta, the 1st January 1873.

S. O. N. JAMES,
Asst. Surveyor General,
In charge Drawing and Compiling Branch.

DR. *Abstract Cash Accounts from 1st January to 31st December 1872* CR.

Items.	Amount.	Total Amount.	Items.	Amount.	Total Amount.
	Rs. A. P.	Rs. A. P.		Rs. A. P.	Rs. A. P.
To Cash Account.			*By Transfer Account.*		
Balance in Bank of Bengal as per printed Report for 1870-71 ...	2,523 0 2		Amount paid to Government by Cheque No. 365, dated 19th February 1872, as per Comptroller General's receipt No. 6598, dated 23rd February 1872	6,000 0 0	6,000 0 0
„ in hand ditto ditto ...	269 10 6		Ditto ditto No. 366, dated 11th May 1872, as per Bank of Bengal receipt sent to the Comptroller General under cover of this Office No. 869, dated 15th May 1872	800 0 0	
„ on account of sale of maps since realized ditto ...	7,625 12 9	10,518 7 5	Amount paid to Bank of Bengal, No. 949, dated 10th June 1872 ...	173 10 9	
To Map Sale Account.			Ditto ditto No. 1023, dated 2nd July 1872	90 4 0	
Amount received from Sundries	584 14 3		Ditto ditto „ 1093, „ 26th „ „	3,036 9 0	
Sales by Curator of Government Books N. W. P.	212 0 0		Ditto ditto „ 1096, „ 29th „ „	212 0 0	
„ by Punjab Printing Company	159 3 2	956 1 5	Ditto ditto „ 1196, „ 24th August 1872 ...	50 0 0	
			Ditto ditto „ 1418, „ 8th November „ ...	50 12 0	
			Ditto ditto „ 1578, „ 21st November „ ...	728 0 8	
			Ditto ditto „ 1743, „ 17th December „ ...	162 0 2	
			Ditto ditto „ 1779, „ 19th December „ ...	20 15 0	
					5,324 3 7
					11,324 3 7
			By Sundries.		
			Amount paid on account of Stores Commission, &c., to the map sale Agents	150 5 3	150 5 3
TOTAL ...	.....	11,474 8 10	TOTAL ...	.....	11,474 8 10

H. L. THUILLIER,
Surveyor General.

APPENDIX L.

Statement of work completed and in progress in the Engraving and Copper-plate Printing Branch Surveyor General's Office, during the year ending 31st December 1872.

PLATES OF THE INDIAN ATLAS.

10 N.W; 11 N.W; 11 N.E; 32 S.E; 32 N.E. Completed and published.

9 S.E; 11 S.W; 33 N.E; 86 S.W; Completed, will be published shortly.

34 N.E; 68 Full plate (old) 124 N.W; 125 N.E. Engraving completed. Some corrections and additions needed. The additions to plate 68 (Oudh) cover nearly one-third of the plate.

2 S. E.—Outline finished; writing well advanced.

2 N. E. Ditto ditto ditto.

2 S. W.—Outline and writing completed; hill etching commenced.

3 N. E.—Outline completed; writing commenced.

9 N. W.—Plate partly engraved in England. Outlines of additions completed; writing in progress.

9 S. W.—Outline and writing completed.

33 S. E.—Outline completed; writing in progress.

34 S. E.— Ditto; writing commenced.

54 S. W.—Outline and writing completed.

58 Full plate (old).—Railways added.

61 Ditto ditto

72 S. E.—Outline commenced.

73.—Full plate (old) portion of old work cleaned off. Outline of additions completed; writing commenced. The work on this plate is heavy.

78.—Full plate (old), repairing the work throughout; writing completed; hills half retouched, plate put down for other work.

87 N. E.—Outline completed; writing nearly finished.

88.—Full plate (old) outline done; writing in progress; additions very heavy.

93 N. E.— Ditto writing commenced.

120 and 121.—Full plates (old), Railway and small corrections and additions completed.

124 S. E; 124 S. W; 124 N. E.—Plates put down for other work.

125 N. W.—Outline and writing completed; hills in progress; plate put down for other work.

131 N. W.—Outline completed; plate put down for other work.

131 N. W.—Outline completed.—Plate put down for other work.

MISCELLANEOUS MAPS, &c.

Map of the Punjab in outline, 32 miles = 1 inch completed and published.

Maps of Oudh, 16 miles 1 inch outline completed.

Simon's plan of the city of Calcutta numerous corrections, additions to 4 large plates in progress.

Additions and corrections to maps of India, No. 2.

Ditto to Index Chart, Great Trigonometrical Survey.

Small Index to 10 mile map of India.

Headings for Topographical Survey sheets.

Altering plates of office imprimature.

Scale 16 inches = 1 mile (in chains) for the Mathematical Instrument Department.

Ruling tints for the Lithographic Branch.

Specimen slips of writing for apprentices and Native Draughtsmen.

COPPER PLATE PRINTING.

Proofs of various kind	...	...	..	521
Transfers for stone ...	...	..	...	357
Impressions of various kinds	...	...	...	12,080
	Total impressions		...	12,958

SURVEYOR GENERAL'S OFFICE,
CALCUTTA;
The 1st January 1873.

(Sd.) C. W. COARD,
Supdt., Engraving Branch.

APPENDIX E.

Abstract of the Drawings executed in the Surveyor General's Office, Lithographic Branch, from 1st January to 31st December 1872.

Scale, &c.	New Maps, &c., the Lithographic Drawings of which were completed during the present year.	Size.	No. of Sheets.
	General Maps.		
8 Miles = 1 Inch ...	Eastern Bengal Sheets, Nos. 7, 8, 9, and 10	Imperial ...	4
16 „ = 1 „ ...	Afghanistan Map Sheets, Nos. 1 and 2. Chalk hills, on stone and Persian names on transfer paper	Special	2
32 „ = 1 „ ...	Eastern Bengal, Burmah, parts of China and Siam, a portion added in 4th Section	Imperial ...	1
	District Maps.		
2 Miles = 1 Inch ...	District Shahabad	Atlas	4
8 „ = 1 „ ...	Burdwan Division Skeleton Map (re-drawn)	Double Elephant ...	1
8 „ = 1 „ ...	Bhagulpur ditto ditto (ditto)	Do. ...	1
4 „ = 1 „ ...	Sindh Compilation Map Sheets, Nos. 1, 2, 4, Chalk hills, on stone	Imperial ...	3
	Revenue Survey Maps.		
1 Mile = 1 Inch ...	Sindh Revenue Survey Sheets, Nos. 43, 45, 46, 47, 48, 57, 58, 59, 60, 61, 70, 77, 80, 81, 84, 88, 89 and 91 ...	Double Elephant, &c.	18
1 „ = 1 „ ...	Oudh Sheets, Nos. 25 and 26	Do. ...	2
1 „ = 1 „ ...	District Lohardugga Sheets, Nos. 7, 8, and 9	Double Royal ...	3
1 „ = 1 „ ...	District Bijhour Sheets, Nos. 5 and 6	Do. ...	2
1 „ = 1 „ ...	Do. Kooch Behar Sheets, Nos. 1, 2, 3 and 4 ...	Do. ...	4
1 „ = 1 „ ...	Do. Chanda Sheets, Nos. 2, 3a, 3c, 7a, 16 and 17 ...	Do. ...	6
	Plans of Cantonments and Civil Stations.		
1,000 Feet = 1 Inch ...	Town and Suburbs of Rangoon	Atlas	4
	Town and City of Delhie	Do.	12
	Thannah Maps.		
½ Mile = 1 Inch ...	Thannah Nakassie Parah, Sub-division Kissenaggur, District Nuddeah	Double Royal ...	6
½ „ = 1 „ ...	Thannah Kaligunj, Sub-division Kissenaggur, District Nuddeah	Do. ...	6
½ „ = 1 „ ...	Thannah Kutwallee Kissenaggur, Sub-division Kissenaggur, District Nuddeah	Do. ...	6
	Barrack Plans.		
	New and old Royal Artillery lines and old Entrenchment, Ferozepur	Various sizes ...	24
	Ferozepur Arsenal	Do. ...	8
	New lines for 1st and 2nd British Infantry Regiment at Trimulgherry	Do. ...	32
	New lines for European Artillery at Trimulgherry ...	Do. ...	12
	Proposed position of the European barracks and subsidiary buildings at Bolarum	Do. ...	28
	New and old European Infantry and Royal Artillery barracks at Neemuch, Sheets Nos. 1, 2, 3, 4, 4A, 5, 5A, 6 and 7	Double Royal ...	22

Abstract of the Drawings executed in the Surveyor General's Office, &c.,—continued.

Scale, &c.	New Maps, &c., the Lithographic Drawings of which were completed during the present year.	Size.	Nos of Sheets.
	BARRACK PLANS,—*continued.*		
	Nusserabad European Infantry and Royal Artillery lines and Garrison cells	Various sizes ...	17
	European Cavalry barracks and out-houses at Secundrabad ...	Do. ...	10
	Agra Artillery and Infantry lines and Garrison in Fort Sheets, Nos. 1, 2 and 3	Do. ...	9
	MISCELLANEOUS.		
	Geological Map of portion of the Madras Presidency, including Kunoor and Caddapah, 8 tint stones prepared ...	.....	1
	Geological Map of sketch plan and section of Bhojia hills, 5 tint stones prepared	½ Sheet Foolscap ...	1
	India showing the sheets of the atlas and present state of the progress of the Geological Survey, 3 tint stones prepared...	Do.	1
1½ Inches = 1 Mile ...	Geological sketch plan of the head-water of Mhur Valley, 3 tint stones prepared	Do.	1
4 Miles = 1 Inch ...	Geological Atlas quarter Sheet, No. 77 S.W. Geological lines inserted, and 11 tint stones prepared.	¼ Sheet Atlas ...	1
4 „ = 1 „ ...	Geological Atlas quarter Sheet, No. 78 S.E. Geological lines inserted, and 9 tint stones prepared	Do. ...	1
4 „ = 1 „ ...	Geological Map of the vicinity of Nagpur, 6 tint stones prepared	¼ Sheet Foolscap ...	1
1 „ = 1 „ ...	Geological Map of Sirban hills in Abbottabad, 7 tint stones prepared	Do. ...	1
Various scales ...	Medical Department maps	Various sizes ...	2
„ ...	Railway Sections	Do. ...	32
„ ...	Sanitary Commissioner's maps	Do. ...	1
„ ...	Foreign Department maps	Do. ...	20
„ ...	Archæological Survey maps	Do. ...	30
„ ...	Public Works Department maps	Do. ...	8
„ ...	Bengal Government maps and plans	Do. ...	21
„ ...	Miscellaneous maps, plans and drawings	Do. ...	107
			476.

J. WATERHOUSE, *Captain,*
Assistant Surveyor General,
In charge Lithographic Branch.

CALCUTTA,
The 23rd January 1872.

ABSTRACT of the printing executed during the year, showing value or selling price of the same.

Subjects.	No. of sheets.	No. of copies.	No. of pulls	Value or selling price.
				Rs. A. P.
District and general maps on various scales	31	8,026	15,883	9,779 8 0
Index maps	8	1,860	1,860	Gratis
Revenue survey sheet maps, 1 mile=1 inch	25	5,676	7,518	8,514 0 0
Thannah maps	20	225	1,500	562 8 0
Plans of cantonments and civil stations	12	714	2,856	2,856 0 0
Block plan of barracks, &c., for Secretary of State	182	2,208	16,744	4,531 0 0
Reprints of old maps	109	9,556	30,946	13,114 10 0
Printed tints on engraved atlas sheets	4	4,033	5,167	681 11 3
Miscellaneous maps	73	20,631	24,431	12,767 3 0
Do. plans and sketches, &c.	230	1,19,497	1,40,744	13,866 12 0
Geological maps and plans	8	5,560	38,512	3,444 12 0
Estimated cost of transfers of headings and foot-notes to the published maps to this department	...	...	...	600 0 0
	702	1,77,986	2,86,191	76,668 0 3
Departmental orders, &c.	...	4,282	4,282	80 0 0
Memoranda and forms for the use of the department	...	1,01,489	1,15,733	1,640 0 0
Forms for Topographical and Revenue Survey orders	...	50,364	1,19,630	1,769 10 0
		1,56,135	2,39,645	3,489 10 0
Cost of Lithographic Branch.				
Permanent establishment	35,926	1	5	
Contingent expenses	1,445	9	2	
Extra contingencies	1,770	8	2	
Actual cost of papers	10,307	5	2	49,449 7 11
Lithographic papers of all sorts, 123 reams	...	...	...	10,307 5 2
Proof „ „ 124 „	...	...	...	
Printing „ „ 214 „	...	...	...	

J. WATERHOUSE, *Captain*,
Assistant Surveyor General,
In charge Lithographic Branch.

The 23rd January 1873.

APPENDIX F.

REPORT by CAPTAIN J. WATERHOUSE, *Assistant Surveyor General, in charge* PHOTOGRAPHIC BRANCH, *Surveyor General's Office.*

AMOUNT OF WORK.—The amount of work may briefly be stated as follows—1,428 original subjects have passed through the office, of which 1,17,320 complete copies have been struck off, besides 4,200 silver prints.

PROGRESS.—The difference in the amount of work turned out during 1872, as compared with 1871, is shown in the table below, from which it will be seen that though some items show a falling off, which may be accounted for by the large size of the negatives now taken, there has been a considerable increase both in the amount of originals received and in the number of complete copies supplied. The increase in the number of silver prints has been very large, owing to the demands of the Archaeological Survey, the International Exhibitions, and also to an increased demand for silver print reductions from maps for the use of the Engravers.

Subject.	1871.	1872.	Difference.	Difference in dec. sq. feet.*
Originals	1035	1428	+ 393	
Negatives	1816	1760	— 56	
	(4892·1 d. s. ft.)*	(4481·69 d. s. ft.)*	.....	—410·41
Silver prints	2561	4200	+ 1639	
	(2510·57 d. s. ft.)	(5230·39 d. s. ft.)	.....	+2719·82
Carbon prints	1827	1892	+ 65	
	(5017·19 d. s. ft.)	(4710 d. s. ft.)	.....	—307·19
Transfer to Zinc or Stone ...	549	635	+ 86	
Number of Pulls	96,725	88,959	— 7766	
Ditto of complete copies ...	1,11,503	1.17,320	+ 5817	

* Decimal square feet of 100 square inches.

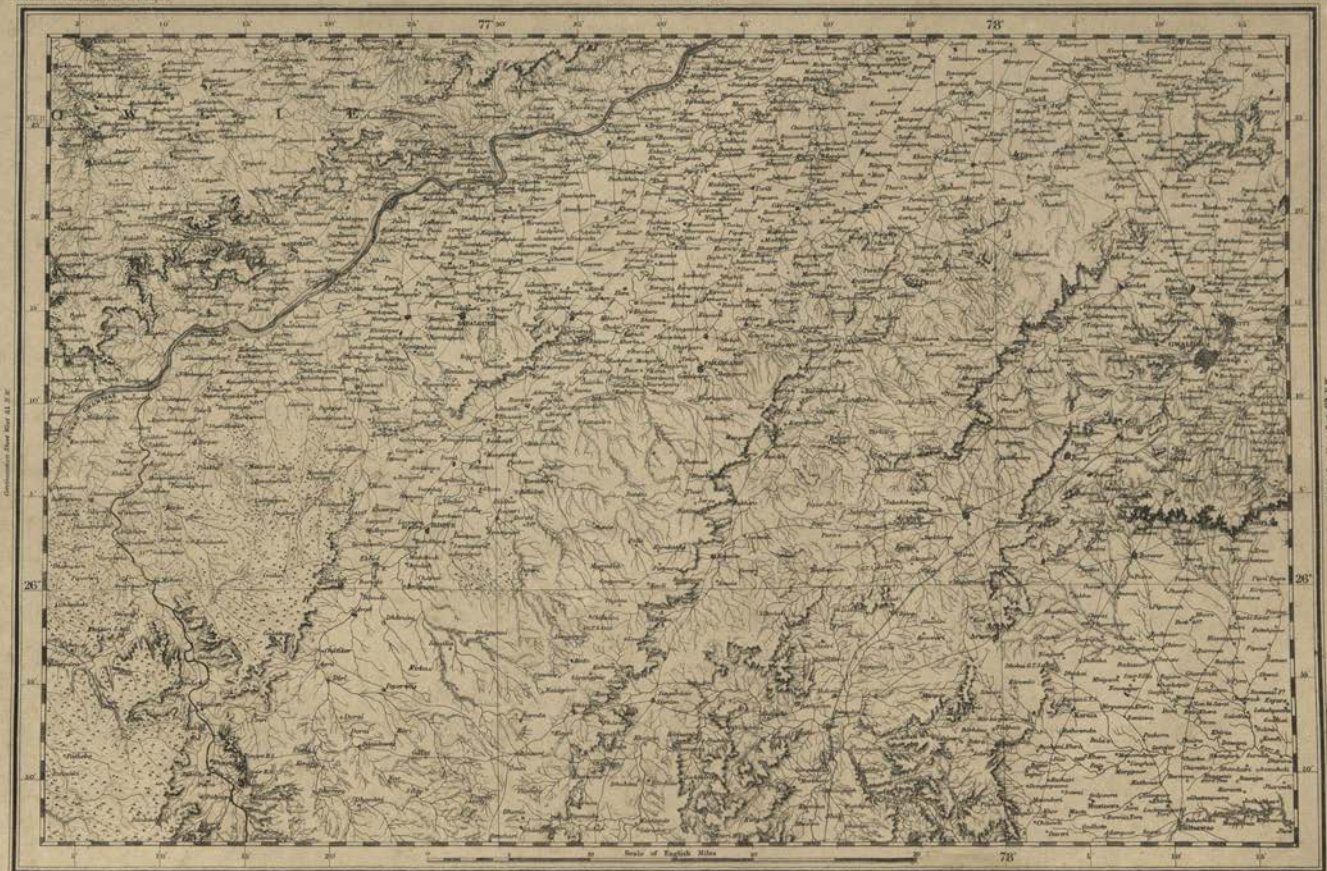
PROCESSES AND PERSONNEL.—There have been but few changes in the processes used, or in the personnel of the Office. Mr. W. Maher, the Assistant in charge of the Silver Printing Department, resigned his appointment in July 1872, and his place has not yet been filled up, though application has been made to secure the services of Sergeant John Harrold, R. E., an experienced photographer, from the school of Military Engineering, Chatham, and news of his appointment is daily expected.

The only improvement of importance in the processes is the use of albumen as a preliminary coating for glass plates, which have become old and stained by use, before using them again. The method has been found very valuable, and enables us to use glasses over and over again, whereas formerly they could seldom be used more than twice or three times.

EXPENSES OF WORKING.—The total expense of working the office during the year, including Superintendent's salary, has been Rs. 50,441-5-5 or Rs. 167-7 less than the expenses of last year. The decrease in expenditure is partly accounted for by the saving of Rs. 870-0-0 of Mr. Maher's salary from the month of July last.

The approximate sum to credit of the department is Rs. 77,928-12, showing a profit of Rs. 27,487-6-7.

PHOTOCOLLOTYPE PROCESS.—Though the hope, expressed in my last report, that this valuable process might be fairly introduced into the office during the year, has not been fulfilled owing to the want of material, and of a skilled printer, considerable progress has been made in working out the process experimentally, and in ascertaining the conditions of working it successfully in this climate. The accompanying specimen will give a good idea of the degree of success already attained in the reproduction of subjects in line, and I now only await the arrival of Sergeant Harrold and the requisite presses and apparatus to fairly start the process, and



SPECIMEN OF A QUARTER SHEET OF THE ATLAS OF INDIA, REDUCED FROM THE SCALE OF 4 MILES TO 8 MILES to 1 INCH, AND PRINTED BY CAPTAIN WATERHOUSE'S PHOTOCOLLOTYPE PROCESS.

Surveyor General's Office, Calcutta, January 1878.

render it available for the practical production of copies of maps and drawings in which extra sharpness, delicacy and finish are required, as well as for replacing the slow and costly process of silver printing for ordinary photographs, required for the illustration of reports or other purposes.

The accompanying description of the working of the process embodying all the latest improvements, may be of interest.

Description of the Photocollotype process in use in the Surveyor General's Office, Calcutta.

The process I have worked out for use in this country, is similar to the processes now well-known in Europe as Heliotype, Lichtdruck and Albert-type, all of them modifications of the original process described by Tessier du Mothay some years ago, and which I saw being worked in 1868 in the establishment of MM. Maréchal at Metz. The printing film is a layer of insoluble gelatine which has been acted upon by light through the agency of an alkaline bichromate, in such a manner that the parts exposed to light become non-absorbent of water in proportion to the amount of exposure, while the protected parts absorb water in proportion to the amount of protection they have received, and consequently, if such a film be wetted and a roller charged with printing ink be passed over its surface, the exposed parts will attract the ink exactly in proportion as they are non-absorbent of water, while the unexposed and fully absorbent parts will repel the ink entirely, in the same manner as the wet parts of the stone in lithographic printing. It will thus readily be seen that from an ordinary photographic negative a print may be obtained, which will reproduce every gradation of tone in the original. Great success has been attained in the production of photographs of this kind, little, if at all, inferior to the ordinary silver prints, and this application of the process will be of immense value in replacing lithography for making copies of drawings for the illustration of scientific papers or reports, as the most delicate gradations of tone can be reproduced with a perfection quite unattainable by the best chalk drawing. Its value for this purpose is further enhanced by its extreme cheapness and rapidity, as may be judged from the fact that a drawing which might take a month to draw in chalk on stone at an expense of at least Rs. 80 or 100, for even a native draftsman, could be reproduced more perfectly in the course of 2 or 3 days at an absolutely trifling expense, not exceeding Rs. 5 for a comparatively large plate. A process of this kind is even more useful in this country than in England on account of the difficulty of obtaining trained skilled draftsmen, and is much required to supply the growing want of a practical and cheap mode of reproducing much of the miscellaneous work of the office in the same manner as photozincography has served us for the rapid reproduction and issue of the original manuscripts maps of our surveys. For reproductions in line also, the process surpasses most of the known processes of photo-engraving, photozincography, or photolithography in the delicacy, clearness and sharpness of the results, as well in accuracy of scale, owing to there being no intermediate process of transfer, and the plate being printed by vertical pressure.

The practical working of the process may best be considered under four heads; 1st, the original drawing; 2nd, the negative; 3rd, the preparation of the printing film; 4th, the printing.

THE ORIGINAL DRAWING.—The great advantage of the photocollotype process over the ordinary process of photozincography, is that any original drawing, whether drawn in lines only or coloured in washes that will give a *good photograph*, may be reproduced by it, while photozincography is only adapted for the reproduction of subjects in line, which even cannot be successfully reproduced unless drawn in black and white in a style specially suitable for the purpose. At the same time it must be borne in mind that the conditions as to necessity for drawings intended for reduction being drawn in a suitable style relatively to the scale of reduction, and as to the effect of photographing certain colours, are of the same importance in the photocollotype as in other photographic processes, and that, therefore, in order to secure the best results, drawings in line must be clearly and firmly drawn in black ink on clean, white, smooth paper and in a style suitable for the scale of the reproduction, while shaded or tinted drawings should be on as smooth paper as possible, and executed in monochrome, either with Indian ink, sepia, neutral tint, or some similar dark colour. These precautions should be particularly observed when preparing drawings specially for reproduction by the process, but in practice many cases arise in which drawings not specially prepared for reproduction by photography, and therefore unfit for reproduction by photozincography, have to be reproduced, and for this purpose the process will be a most valuable aid. Another point of the greatest importance is the necessity for the drawing being complete in all respects before it is given to be reproduced, as, though possible to a certain extent, it is not easy nor desirable to make alterations on the printing plates.

THE NEGATIVE.—As the printing surface receives the image direct from the negative and not by transfer as in photozincography, the necessity for the negative being *reversed* will readily be understood.

There is no great difficulty in obtaining reversed negatives by either of the three following methods.

(1.) By the use of a reversing mirror or prism.

(2.) By taking the negative through the glass plate instead of on its surface, *i. e.*, by turning the glass in the camera so that the collodion film may be turned away from the lens instead of facing it, as usual.

(3.) By coating an ordinary negative with gelatine, or transfer collodion, and stripping it off the glass.

The first and most simple of these methods has not yet been tried in the Office, but a silvered glass reversing-mirror has been indented for from England, and will probably prove the most useful means for the purpose.

The second plan has been tried with some success, and was, until quite lately, the only method employed for the purpose. There are, however, several disadvantages connected with it, of which the principal are the difficulties of obtaining photographic glass free from bubbles and other defects which leave their mark upon the sensitive film, and of accurately judging the time necessary for the exposure through the glass, owing to some glasses being thicker than others or deeper in colour; there is also the uncertainty of the focus being exactly sharp, and the impossibility of taking sharp pictures beyond a certain size, owing to the refraction of the glass causing a divergence of the more oblique rays, and thus throwing out of focus the details at the corners of the plates. On account of these difficulties I have lately made a trial of the 3rd, or transfer method, with success, and this plan would answer all purposes perfectly well, were it possible to prevent the gelatine film from contracting after it leaves the glass, but this serious defect seems likely to render it useless for map work, unless the usual amount of contraction can be estimated and allowed for. In other respects the collotype process is capable of giving most accurate reproductions to any desired scale, and it is therefore highly important that the reversed negatives of maps should be absolutely true to scale. For transferring ordinary negatives or others in which scale is of no consequence, the contraction is unimportant and the method may be used with advantage.

The *modus operandi* is as follows :—

After the negative has been taken by the ordinary method, it is carefully levelled and surrounded by a wall of putty or dough. A solution of gelatine composed of—

Gelatine	1 oz.
Water	8 ozs.
Glycerine	1 dram

is poured on it and left to dry in a place free from dust ; as soon as the film is dry, a knife is run round the four sides and the film instantly peels off the glass. Sometimes the gelatine film receives a coat of collodion to which a little castor oil has been added, and is thus better protected from atmospheric influences.

It is probable that the use of transfer collodion instead of gelatine would obviate many of the disadvantages caused by the contraction of the latter, but the method is much more expensive, and in a few trials made with it has not proved a success in this climate. The best means of making these reversed negatives absolutely accurate requires further experiment.

THE PREPARATION OF THE PRINTING PLATE.—It has been before stated that the printing plates are of glass. The ordinary plate glass about ⅜ inch in thickness is the kind we have hitherto used, and seems to answer very well. The plates are ground on one side with very fine sand. When required for use they are thoroughly cleaned in the usual manner and carefully levelled by means of tripod levelling screws placed so as to form an isosceles triangle corresponding to the size of the plate; this method is much more convenient than using the ordinary levelling stands.

While the plates are being levelled, the gelatine solution is prepared as follows—

A	Gelatine	1 oz.
	Sugar	1 dram
	Distilled water	6 ozs.

heated in a water bath till the gelatine is dissolved.

B	Honey Soap	30 grains
	Distilled Water	1 oz

boiled till the soap is dissolved.

C	Tannin	10 grains
	Water	1 oz.

The above quantity will be found sufficient for two square feet of plate.

As soon as the gelatine solution A is quite ready, solutions B and C are mixed together hot and poured gradually, with constant stirring, into A. The whole is then strained through two thicknesses of coarse cotton cloth, and poured evenly over the plates, any bubbles being removed with the point of a penknife. The plates are then covered over with a light paper cover to prevent dust falling on them, and in the cold months will *set* firmly in about an hour, when they may be removed into the open air and turned face downwards upon small blocks of wood at their corners to remain till quite dry, which will be in from 12 to 24 hours. In the hot weather and rains, however, they will neither set nor dry so readily, and it will be advisable to increase the setting power of the gelatine by substituting one ounce of spirits of wine in place of the water used in dissolving the tannin, and in the rains a drying box must be used for drying the plates.

When the plates are dry, they may either be put away till required, or sensitised at once in a bath of—

Bichromate of potash	1 part
Water	20 parts

They are allowed to remain in this for about 5 minutes, and are then removed to a drying box and dried with a gentle heat. When dry, the deposit at the back of the plates, as well as any inequalities at the corners of the gelatine film, are removed, and the plates are ready for exposure to light under the negative.

This operation is performed in a pressure frame in the same way as for ordinary photographs. It is advisable, however, to secure clean margins by shielding the borders of the negative by means of a mask, cut out in yellow or brown paper, which should well overlap the edges of the printing plates. The mask is laid on the glass of the pressure frame, then the negative in its proper position (should this be a transferred film, it is advisable to place a glass plate between it and the mask, in order to secure the most perfect contact); the sensitive plate is then rubbed over with a little powdered soapstone (called in the bazars *Tel Khurri*), to prevent its adhesion to the negative, and adjusted in its place over the negative, covered with a sheet of black velvet or brown paper over which a thick glass plate is laid, and, if necessary, a few sheets of thick paper to give a good strong pressure, when the bars are shut down. The thick plate of glass has been found to give much sharper and more even contact than the usual back board.

The amount of exposure to light varies from about 10 minutes in the sun for a clear line subject to from 25 to 50 minutes for a subject in half tones according to the subject and intensity of the light, but, as it is impossible to judge of the progress of the printing by inspection, it is necessary to use an actinometer as a guide to the exposure, and nothing of the kind being available in India, I have made up an instrument which seems to answer the purpose very fairly. It consists principally of a box, in the lid of which is fixed a translucent scale divided in 14 squares of different densities; No. 1 being almost quite transparent while No. 14 is almost perfectly opaque, numbers corresponding to the densities being painted in opaque colour on the scale.

The body of the box contains a grooved block for carrying the sensitive film, whether on paper or on a glass plate and a strip of vulcanite for pressing it into close contact with the scale.

As it is advisable that the composition of the sensitive film used with the actinometer should be exactly the same as that of the printing plates, strips of glass are coated with the gelatine mixture, sensitised, and dried at the same time and in the same manner as the printing plates, and thus the progress of the action of the light can be watched and timed very closely.

The mode of using the actinometers is very simple. The sensitive test plate, having been inserted in its place in the instrument, is exposed to the sun at the same time as the printing plate, and when the necessary time of exposure is about expired, is examined, when if an inspection of the scale shows that the action has gone far enough, the printing plate is removed from the light, but if not sufficiently printed it remains longer. It is a good plan when the exposure appears to have been sufficient, to plunge the test plate into water when the full effect of the light will immediately become visible, and, if necessary, more exposure may be given to the printing plate.

When the exposure to light is considered sufficient, the negative and mask are removed and the *back* of the sensitive plate is then exposed to light for about 5 or 10 minutes to thoroughly harden the gelatine, and prevent it from swelling too much in the after processes. It is as well to carry on this second exposure under a piece of ground glass, otherwise if there should be any scratches on the back of the sensitive plate, or on the glass of the pressure frame, they will show as white lines on the print; after this the plate is taken out of the frame, a little tallow is rubbed round the edges to prevent water getting underneath and stripping the film, it is then plunged in water and thoroughly washed till all traces of bichromate have been removed, and is ready for printing.

I have tried several other compositions for preparing the printing films and most of the other published processes, but though the dark colour of the tanno-gelatine film prevents the action of light being easily seen, and is also objectionable when rolling up in the press, I have found it the most manageable in the climate of Calcutta, and in some respects better than any other I have experimented with.

Up to the present time the work done has been of comparatively small size, not exceeding 20 × 15, but it is most desirable that the advantages of the process should be extended to the reproduction of our large standard maps of the Topographical and Revenue Surveys. When the process is once fairly started, and the conditions of successful working better known, this subject will receive my full attention.

THE PRINTING.—The plates may be printed in the lithographic press, and then require to be fixed on a level stone with plaster of Paris. It has been found, however, more convenient, and in other respects better, to print them with vertical pressure in the ordinary Albion press,

and, in order to prevent their being broken, the bed of the press is fitted with 2 or 3 thicknesses of kamptulicon, besides a sheet of vulcanised Indian rubber on which the plate rests. It is also desirable to place a sheet of white paper over the bedding in order to enable the state of the plate, when it is being inked up, to be better seen.

The plate having been well soaked in water is laid on the press, and, after being wiped, to remove the excess of moisture is inked in, if a line subject, with an ordinary lithographic roller charged with an ink composed of lithographic chalk ink thinned with a little olive oil, followed by a rolling with a smooth roller to clean away the superfluous ink; a mask of the required size is laid on the plate, over this comes the printing paper covered with a piece of soft felt to drive the paper well into the hollows of the plate, the tympan is lowered, and the impression pulled in the ordinary way. The plate is then damped, and the work goes on in the same manner without difficulty.

For printing in half tones, however, the process is somewhat different, and to obtain uniformly successful results, requires considerable skill and experience. As far as we have gone the following procedure has given the best results.

The plate is first inked in by means of a small leather hand-roller charged with stiff ink (rendered stiffer, if necessary, by the addition of a little Canada balsam) which takes only on the deeper shadows, the half tones are then brought out by rolling in with a smooth lithographic roller charged with a lighter and softer ink. Rollers composed of glue, treacle, soap and catechu have been found useful in certain cases for inking in the plates, but, on the whole, the lithographic rollers are preferred. The impressions are best when printed on enamelled paper, but a smooth glazed printing paper also seems to answer well.

Before putting away the plates after printing, they are washed with turpentine, followed by a very weak solution of caustic potash, to remove all traces of the greasy ink; they may also be treated after this with a mixture of gum and glycerine with advantage.

Corrections.—A point that seemed likely to greatly interfere with the extended use of the process in this office, was the difficulty of making corrections on the plates. I am glad to say that some experiments lately tried have shown that it is practicable both to insert and to take out or clear up details on the gelatine films.

The insertion of details may be accomplished by two or three methods. The first is by writing in the required additions on the dry plate with a pen or fine brush, using an ink composed of bichromate of potash, used alone, or slightly coloured with Indian ink or Indigo. After the additions are completed, the plate is exposed to the light for 10 minutes or ½ of an hour till the bichromate is thoroughly reduced, and may then be washed and printed as usual. In some cases the same object may conveniently be accomplished by brushing over the part with solution of bichromate of potash, allowing it to dry, and then printing in the required details from another negative.

A third method which recommends itself by its simplicity, is to draw in the additional details with an ink composed of solution of chrome alum, this acts instantaneously and requires no exposure to light. It has, however, been found not quite so easy to use as the bichromate solution, but further experiment in this direction is still required.

The use of these methods of drawing upon the gelatine film, opens up a large and very important field of research as to their applicability in many cases as a substitute for lithography. I know that it is possible to produce line drawings in this manner, and believe that it would be quite possible to produce tinted drawings also, and, if possible, shall give my attention to the subject during the coming year.

Experiments have shown that details may be taken out by the aid of a solution of caustic potash or cyanide of potassium, and, should a plate print dirty, it may be cleaned up and greatly improved by the use of a weaker solution of the same substance.

Such are the details of the process as far as they have been worked at present, there is however much to be done; but with the large amount of current work constantly on hand, it is most difficult to find time to devote to working out an entirely new method of printing; and nothing much can be done till my full establishment is completed by the arrival of a photogrpher from England who will be able to take the work in hand. I trust, however that next year I may be able to report considerable progress in the usefull application of this valuable system of photographic reproduction.

Sergeants J. and B. Mackenzie have rendered great assistance in the working out of the process, the first in making the reversed negatives, the latter in bringing his skill as a printer to bear on the difficulties experienced in printing by the new system.

(Signed) J. WATERHOUSE, *Captain,*
Assistant Surveyor General.

ABSTRACT of work performed in the Photographic Branch of the Surveyor General's Office from 1st January to 31st December 1872.

Maps Photographed.	No. of Sections or Sheets.	No. of Negative Plates.	Prints. Silver.	Prints. Carbon.	Transfers to Zinc.	No. of Pulls.	No. of complete copies.	Remarks.
Topographical Survey Maps	203	194	110	160	79	18,095	18,095	
Revenue Survey Maps ...	646	705	29	908	215	18,134	*16,674	*3,700 Anastatised.
District Maps ...	16	61	97	87	31	8,267	† 4,682	†1,230 Ditto.
General Maps ...	56	203	36	271	85	16,897	11,240	
City and Cantonment Plans	28	53	...	37	9	2,955	1,025	
Miscellaneous Maps ...	479	544	3,928	429	145	22,659	‡65,604	‡85 Ditto. 2,216 Zincographed.
Zincographic and Anastatic Transfers	...	...	...	...	71	...	...	
Proofs	...	...	...	...	...	1,952	...	
Total ...	1,428	1,760	4,200	1,892	635	88,959	1,17,320	

STATEMENT showing the cost of working the Photographic Branch of the Surveyor General's Office from 1st January to 31st December 1872.

Dr.	Number of complete copies.	Rs. A. P.	Cr.	Rs. A. P.
Topographical Survey Maps ...	18,095	17,417 8 0	Superintendent's salary from 1st January to 31st December 1872	9,561 14 0
Revenue Survey Maps ...	12,974	21,844 4 0		
District Maps	3,452	5,244 0 0	Sanctioned Establishment and house rent from 1st January to 31st December 1872 ...	21,990 14 2
General Maps	11,240	12,661 4 0		
City and Cantonment Plans ...	1,025	2,557 8 0		
Miscellaneous Maps	63,303	4,310 14 0	Contingencies, inclusive of chemicals received from the Government Medical Store Department and England ex "*Yeddo*," "*British Army*" and "*Agra*"	8,141 15 9
Anastatised Maps	5,015	8,098 12 0		
Zincographed	2,216	192 8 0		
Silver Prints	4,200	5,602 2 0		
			Cost of Paper	10,746 9 6
			Balance in favor of the Department ...	27,487 6 7
Total ...	1,21,520	77,928 12 0	Total Rupees ...	77,928 12 0

J. WATERHOUSE, *Captain,*
Assistant Surveyor General,
In charge Photographic Branch,
Surveyor General's Office.

GENERAL REPORT

ON THE

Topographical Surveys of India,

AND OF THE

SURVEYOR GENERAL'S DEPARTMENT,

FOR SEASON

1873-74.

BY

COLONEL H. L. THUILLIER, C.S.I., F.R.S., &C.,

SURVEYOR GENERAL OF INDIA.

SUBMITTED TO THE GOVERNMENT OF INDIA, DEPARTMENT OF REVENUE, AGRICULTURE, AND COMMERCE.

CALCUTTA:

OFFICE OF SUPERINTENDENT OF GOVERNMENT PRINTING.

1875.

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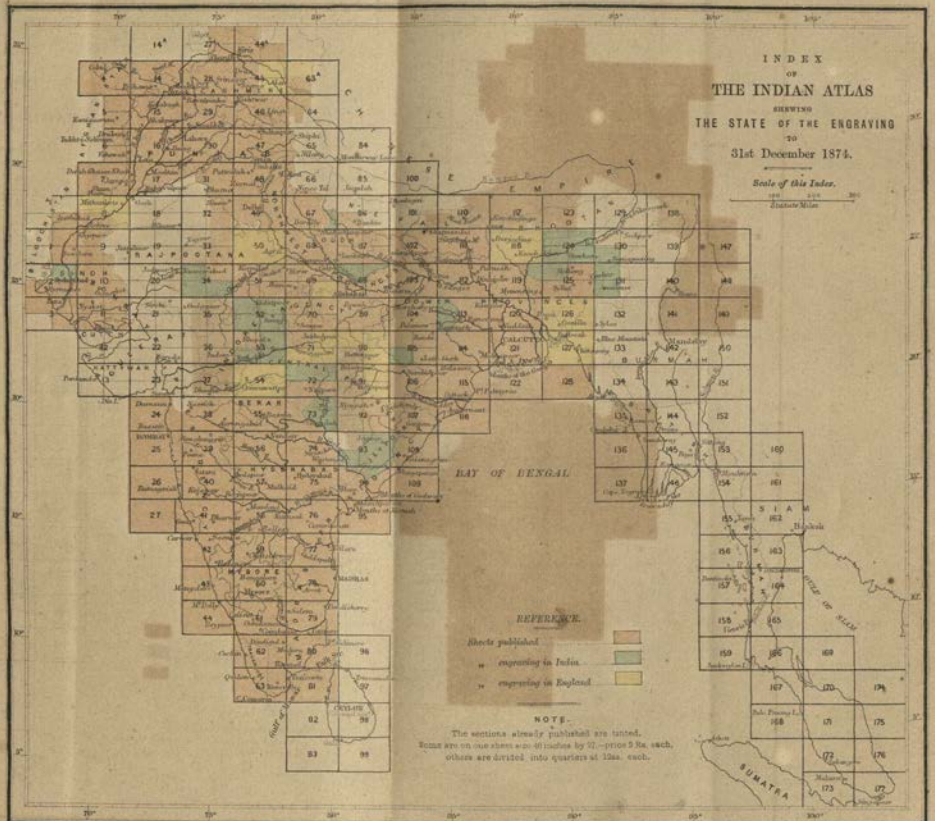


Published under the direction of Colonel H.L.Thuillier F.R.S. Surveyor General of India.
Surveyor Generals Office, Calcutta.
July 1875.

GENERAL REPORT

OF THE

Topographical Surveys of India,

AND OF THE

SURVEYOR GENERAL'S DEPARTMENT,

FOR SEASON

1873

No. 154 B, dated Calcutta, 15th January 1873.

Introductory.

The general results of the operations of the Topographical Surveys of India, for the professional season of 1871-72, *viz.*, from 1st October 1871 to 30th September 1872, and the progress of work in the several branches of my head-quarters office, for the year ending 31st December 1872, are described as usual in the following report submitted in continuation of my general report, No. 150 B, dated 24th January 1872.

2. The frequency of these reviews of a single operation or description of surveys, carried on year after year on the same principles and with the same officers and men, over vast tracts of territory, which of necessity must occupy a long course of years in the completion, naturally entails much sameness of details and repetition of explanations, for which allowance must be made in the perusal of the history of a department so constantly describing its own proceedings and results. The professional and other details are more given as a necessary and useful record of departmental events, which from thus being strung together and printed annually, may hereafter be found and referred to, with greater certainty and convenience.

Surveys in progress.

3. The number of the Topographical Surveys under my direction has, by the resuscitation of No. 2 Party for Khandesh and Bombay Native States, been again raised to seven, as originally constituted prior to 1870; the prosecution of each field of survey has been carried systematically on towards filling up each degree of blank country in the respective divisions, so as to provide for each sheet of the Indian Atlas in due order. The several executive officers have again pursued their laborious course with equal advantage and success, and were, during the season under review, thus employed:—

No. 1.—Under Lieutenant T. H. Holdich, R. E., Assistant Superintentent Officiating in charge, in portions of the Native States of Gwalior, Holkar's Territory, Kotah, Tonk, Jhalawar and Kurwai, within the limits of the Indore and Rajputana Agencies;

No. 2.—Under F. B. Girdlestone, Esquire, Officiating Deputy Superintendent in Khandesh (Bombay Presidency), and the Native States lying between the Nerbudda and Taptee Rivers of Burwani, Dhar, Holkar and outlying portions of Sindiah's Territory in the Rajputana Agency embracing a continuation of the Sathpura Range, and the completed Surveys of the Central Provinces;

No. 3.—Under Colonel G. H. Saxton, Deputy Superintendent, in portion of Bustar Dependency of the South-Eastern portion of the Central Provinces, and in Jeypur, Panchpenta, Madgul and Vizianagram, in the Vizagapatam Agency of the Madras Presidency;

No. 4.—Under Major G. C. Depree, Deputy Superintendent, in the northern zemindarees of district Belaspur and district Mandlah in the Central Provinces, and in Tolooka Sohagpur of the Rewah State, in continuation of former work in the Chota Nagpur Province.

5. The decrease in the area of final topography of 1,223 square miles is due to a slightly smaller outturn than last season in the area accomplished by No. 6 party, employed on the military reconnoissance and exploration of the Eastern Frontier, in the Naga Hills and the Manipur State, over ground which can only be visited for a very short period of the year under proper political protection and guidance, and in which even during the winter months the weather is most uncertain for observing.

6. The progress of these small scale military reconnoissances or explorations, depending on so many conditions, physical as well as political, the areas achieved one season with another, must of necessity vary, but the out-turn of both years has been large and most promising towards a complete delineation of the topography of this long unknown and intricate Frontier.

7. These general results are most satisfactory, and, considering the great difficulties of much of the ground both in the hills and plains in which the several parties are now operating, are highly creditable to the executive officers under whose direct management the season's field work was conducted, and to the efficient and zealous exertions of the European staff. As usual, a very full and large area has been returned by every party, and no disappointments have occurred anywhere, notwithstanding the variety of the nature of the operations, and of the peculiarity of the different widespread fields of employment.

8. In Statement *C* (Appendix) a comparison of the general results, total expenditure and average mileage rates for the seasons 1872-73 and 1873-74 is shewn.

Season's fair mapping.

9. The season's fair mapping is represented on 38 standard sheets (15′ of latitude by 30′ of longitude) of which 27 are on the full scale of 1 mile to the inch, and 11 on 2 miles to the inch: these embrace a total area of 21,383 square miles, nearly all of which has already been reproduced by photozincographic transfers.

10. A great portion of this has also been reduced and compiled in outline on the ¼ inch (4 miles=1 inch) scale in my Drawing Office at Head Quarters for the sheets of the Indian Atlas, now in the engraver's hands, and the remainder will very soon be ready in a similar form.

Nos. 20 N. E., 20 S. E., 34 N. W., 34* S. W., 35 S. E., 35 N. E., 36 S. E., 37 N. W., 52 S. E., 52 N. W., 52 S. W., 53 S. W., 53 N. E., 53 S. E., 54 (old full plate) 71 N. E., 71 S. E., 90 N. W., 90* S. E., 90 S. W., 93 S. W., 94 (old full plate) 119 (old full plate) 124 S. E., 130 S. E, 130 S. W., 130 N. W., 131 N. W., and 131 S. W.

NOTE.—Those marked with an asterisk will be completed.

11. These geographical materials will enable us to fill portions of the Atlas Sheets marginally noted, filling up all blanks for complete editions of those marked with an asterisk.

Simla and Jutog 8 sheets—scale, 24 inches = 1 mile.
Ditto 1 sheet hills in brush shading, scale 8 inches = 1 mile.
Erinpura, 1 sheet, scale 12 inches = 1 mile.
Beawur or Nyanagar, 1 sheet, scale, 12 inches = 1 mile.
Mahesar city, 1 sheet, scale, 12 inches = 1 mile.
Airi forest reserve (district Mandla), 1 sheet, scale, 4 inches = 1 mile.
Chaoriagoghur forest reserve (district Mandla) scale, 4 inches = 1 mile.

12. Large scale plans, in sheets, of the several civil and military stations and forts and cities in the Native States, as per margin, have been rendered by executives, all of which, with the exception of the general reduced plan of Simla and Jutog, which must be treated by lithography, have been reproduced by photozincographic transfers, and are available for issue

Combined results of Topographical and Revenue Surveys for the season.

13. By the Imperial Topographical and Revenue surveys under my control, a total area of 44,004 square miles, at a total cost of Rs. 14,38,371, has been completed during the season. By Revenue Survey, on the scale of 4 inches=1 mile, 4,708 villages have been completed, together with 804 blocks, without the definition of village boundaries, on a scale of 2 inches=1 mile. In the Upper Circle of superintendence under Colonel J. E. Gastrell, the Cadastral survey in the North-West Provinces (scale, 16 inches=1 mile) of 1,763 villages, embracing 1,501,398 fields, have been executed at a cost per acre of 3 annas 6 pie, or 8 pie less per acre than during the previous season. The grand area accomplished by the Revenue Survey will now be reduced annually by the number of parties employed in the cadastral or large scale measurements of fields, which, of course, render progress much slower, and diminishes the amount of the ordinary 4-inch survey for Topographical purposes.

	Area.	Cost.	Average rate.
	Sq. miles.	Rs.	Rs. As.
Topographical surveys ...	24,103	4,25,041	17 10 per sq. mile.
Revenue surveys ...	17,371	6,63,128	38 3 ditto.
Total ...	41,474	10,88,169	26 4 per sq. mile.
Cadastral surveys, scale 16 inches=1 mile	2,530	3,50,202	3 6 per acre.
Total ...	44,004	14,38,371	

14. All details connected with the execution, progress and cost of the Revenue Surveys will be found in the Administration Report of that branch of the Department, which is separately submitted by the joint Superintendents.

15. In para. 16 of the last report, the aggregate results of the modern Topographical and Revenue Surveys up to 1873 were given. This information, completed up to date, is as follows:—

Aggregate results brought up to date.

	Area in sq. miles.	Cost, Rs.
Total up to 1873	743,802	2,00,28,330
Add for 1874	44,004	14,38,371
Total up to 1874 ...	787,806	2,14,66,701

16. This enormous area of nearly 800,000 square miles represents what has been accomplished by only two branches of the department, in about the past thirty years, almost wholly under the superintendence of the same officer. The entire results have been published in various forms and on different scales.

17. In 1857 the first great effort was made to render the officers of Government more generally conversant and familiar with the country, by the publication and issue of general maps on moderate scales through the agency of lithography only; the demand for these was excessive for the use of troops marching in pursuit of rebels, and by Civil Officers for local administrative purposes. Ere long larger scale maps were demanded both for military and civil objects, local improvements, railways, canals, new roads, &c., and fortunately the new system of photozincography came to our help and enabled us, after some difficulties and disappointments were overcome, to reap great benefits, which could not otherwise have been met, and up to the present time the requirements of the public service continue ever increasing, taxing the resources of the field establishments for new surveys and of the Head-Quarters compiling and publishing offices to the very utmost.

18. In the appendix, the progress in detail, during the past year, made in the Drawing, Geographical, Compiling and Engraving branches is given in a Tabular Statement by Mr. J. O. N. James, Assistant Surveyor General, the indefatigable officer in charge. It is impossible to convey any adequate idea of the nature and extent of the work performed, or of the real progress made in the compilation, drawing and copying of Maps, Plans and Charts on various scales, without entering into very minute details, more especially when it is necessary to utilise the latest survey results for the correction of old materials, and to keep abreast of the yearly progress of surveys: this remark applies equally to the engraving of maps of such a country as India. All that can be done is to state what sheets of different provinces or smaller territorial sub-divisions have been dealt with, or which may be in various stages of progress, and this briefly is as follows as regards the more important compilations and maps.

Cartography.

19. The work of completing all the old sheets of the Indian Atlas and such as were left partly blank on the transfer of the engraving from England to India, by incorporating the results of the latest surveys, as well as the preparation of drawings for new sheets from materials annually furnished by the Topographical and Revenue Surveys in progress, continues to receive earnest attention, and I have much satisfaction in stating that the greater portion of the results of the past season's Topographical surveys have been rendered and compiled in outline for the Atlas Sheets, and are in the engraver's hands. The sheets of the Indian Atlas marginally noted have all had considerable additions made to them to bring them up to date.

Sheets of the Indian Atlas.

34 N. W. and S. W.; 49 old full size plate; 52 N. W. N. E. S. W., and S. E.; 54 N. E.; 67 old full size plate; 72 N. W.; 93 N. E. and S. W.; 105 S. W.; 106 old full size plate; 107 and 108 old full size plate; 113, 115, 116, 119 old full size plates; 124 N. E. S. E. and S. W.; 125 N. E. S. and N. W.; 130 S. W.; 131 N. W. and S. W.

20. For the plates still engraving in England additions have been made to the following:—

50 old full size plate; 71 N. W. and S. W.; 89 old full size plate; 90 N. W.; 104 and 118 old full size; 126 four quarters; 127 four quarters; proofs examined and corrected 8 S. E. 69 S. E.; 70 N. E.; 92 S. E.; 105 N. W.; 128 N. E.

All the above have been returned to the Geographical Department at the India Office. Additions to date are being inserted on sheets 90 S. E. and N. E. and 91 N. E. and S. E.: these as soon as ready will also be forwarded to the India Office for completion of the engraving.

21. A compilation of the province of Assam comprising the new Chief Commissionership, scale 8 miles=1 inch, as a sister map to that of Bengal on the same scale, has been started. This map has long been a great desideratum, but in consequence of the obstacles and delays in the progress of the trigonometrical operations up the valley of the Brahmaputra river, not yet completed, no geodesical co-ordinates were available for the compilation of the results of the Revenue Surveys long since executed in the eastern and northern districts of this province.

Geographical and miscellaneous maps and compilations.

22. A new map of Bhutan (scale 8 miles=1 inch) has been completed and lithographed. District Darjeeling (scale 4 miles=1 inch) completed and lithographed. Districts Chindwara and Hazara (the latter in English and Persian in outline only) completed and published. The Garo Hills district, Assam (scale 2 miles=1 inch), compiled and published. Compilations in

outline of the districts of Nowgong, Sibsagar, and Lakhimpur in Assam and of Baitul and Raepur in the Central Provinces (scale 4 miles=1 inch) are in progress.

23. Skeleton maps of the Divisions or Commissionerships (scale 8 miles=1 inch) of Patna, Dacca and Cooch Behar, and of the several districts marginally noted (scale 4 miles = 1 inch), were prepared and published to meet the urgent demands of the Government of Bengal and of local officers to illustrate the famine relief operations.

Lower Provinces of Bengal.
1. Lohardugga.
Shahabad.
Monghyr.
Bhagulpur.
5. Purneah.
Midnapur.
Burdwan.
Jalpiguri.
Southal Pargunns.
10. Chumparun.
Sarun.
Tirhoot.
Bankura.
Singbhum.
15. Rajshahi.
Gaya.
17. Cooch Behar.

24. The map of Sindh (scale 16 miles=1 inch) has been completed and is now engraving. Various additions have been made to the standard map of India, scale 32 miles=1 inch, and it is expected that some of the sheets will soon be ready for Photozincographic reproduction (in outline only) as a preliminary issue; considerable additions from survey have also been made to the map of India, scale 64 miles=1 inch, and the engraving in outline is well advanced.

25. Of the maps of the earlier Topographical surveys referred to in paragraph 28 of my last report, 10 of the Chota Nagpur Division Survey and 10 of the Old Ganjam and Orissa Survey have been fair drawn and 20 are in progress in various stages, with a view to reproduction by the photozincographic process, and so to bring out the whole series of the entire Topographical surveys from the commencement.

26. A very large amount of miscellaneous drawing and copying, examination and correction of proofs, &c., as usual, has been accomplished in addition to the above, whilst the coloring of printed maps forms a very serious business of itself, not only for the regular issues of the current survey maps, but for report and book publishing, the demands for which from all the local Governments continue unabated. The very large amount of work thus performed, and the severe pressure thus put on the office the moment any map is printed, entails considerable expenditure in the contingent bills for the coloring, which is of necessity chiefly done by extra job work.

27. Very good progress has been made during the year in the engraving of Atlas Sheets, and especially of other maps of a more general character.

Engraving.

28. Of the Atlas Sheets published during the year,* 2 S. E., 9 N. W., and 72 S. E., are complete up to margin, the remaining four have blanks awaiting further materials from surveys in progress.

* 2 S. E. Sindh, finished in August.
9 N. W. „ „ „ April.
9 N. E. „ „ „ October.
53 S. W. Central Provinces finished in Dec.
72 S. E. ditto ditto.
124 S. W. Assam, finished in July
131 N. W. ditto in October.

7 Plates.

29. Various additions and corrections, &c., have been made on 34 new and old plates as detailed in the appendix, such as the insertion of new roads, canals, railway lines, recutting of names on much worn plates, repairing of worn out hill work, filling in of small blanks, &c., and 33 plates in various stages of progress are in the engravers' hands, several of which are new quarter plates, some fast approaching completion, others completed in outline, and some just commenced. It is expected that a large proportion of these will be completed and published during the current year (1875).

30. The present state of the engraving of the sheets of the Atlas of India is shown in the Index Map attached to this report, and by a comparison with the Index Map given with the report for 1870-71, the great progress made in publishing the sheets, since the engraving has been carried on in this country, will be apparent.

31. For the *Imperial Gazetteer* the following small scale maps have been engraved: Bengal, Behar, Orissa and the province of Assam, scale 32 miles=1 inch. The Presidency Division, Burdwan Division and Eastern Districts of the Dacca Division (3 maps), scale 16 miles=1 inch. A map of Oudh for the Local Gazetteer, scale 16 miles=1 inch, has been completed. Sindh on the same scale has just been commenced for the same purpose. After much labor and many heavy corrections and revisions, the four plates of Simm's plan of the town of Calcutta are now approaching completion, and a new edition will be shortly issued.

Engraving of Gazetteer and miscellaneous maps.

32. The new map of India scale 64 miles=1 inch, in four sections, which forms such a desideratum, has been well advanced in outline and names, and every effort is being made to publish as soon as possible, a preliminary edition, on which the portions of country which have not yet come under survey and cannot therefore be inserted on the copper, will be filled in from the best available sources, and printed from the stone.

33. The progress report of the Engraving Branch given in the appendix, enters into full detail as to all the miscellaneous work performed, which is very considerable.

34. During the year 1874 the following engraved copper plates were received from the Geographical Department of the India Office : 1 S. E. ; 51 N. W. ; 70 N. W. ; and 105 S. E.

Copper-plate printing.

35. The amount of copper-plate printing accomplished is as follows :—

Transfers	662
Proofs	1,206
Impressions or copies ...	10,529
TOTAL ...	12,397

Several excellent district maps on the ¼ inch scale have been obtained by transfers to stone taken from the plates of the atlas and rubbing off the parts not affecting the district, thus saving the cost and labor of re-drawing for lithography ; and this system will be continued in future for all districts where the plates are available.

36. The great advantages resulting from the engraving of the sheets of the Indian Atlas in India, and possessing the plates here, are now becoming more and more apparent. The results of surveys in progress are annually added on to a large number of plates, and ere long a very considerable portion of these will be ready for issue in a complete form, filled up to margins. All plates for which complete survey results are available are at once finished and published. Blanks in various plates of old date are filled without delay from new surveys in progress. New lines of road, canals, and railways, are added on from time to time, and worn plates are renewed by means of native agency. Various additions and corrections, consequent on local changes and improvements, are likewise effected.

37. Mr. C. W. Coard as superintendent, and the European staff of engravers, continue to give me every satisfaction.

38. The native engravers and apprentices, 30 in number, show steady improvement, and some very creditable work has been turned out by the best of them. The utmost exertions continue to be made in training the native agency and bringing them on to take part in the real work of the Department.

Photographic Branch.

39. During the past year, Captain J. Waterhouse, Assistant Surveyor General in charge, reports (*see Appendix*) that 1,280 original maps, charts and plans have been dealt with in this branch of the office : 812 transfers have been made to zinc : 1,53,242 complete copies of maps, &c., have been printed, besides 1,324 silver prints and 1,495 photo-collotypes.

40. No less than 27,800 copies of outline maps of districts and divisions in Western and Northern Bengal were printed to meet the demands of the local administration for the purpose of aiding the famine relief operations.

41. The following abstract shews the nature and amount of the work completed, compared with that of the year 1873 :—

Maps or subjects.	Number of sheets or sections.	Number of zinc printings.	Number of complete copies.	Remarks.
Topographical survey maps ...	140	21,565	21,760	In addition, the following work was performed :—
Revenue survey maps	689	46,676	39,068	Collotypes 1,495
District maps	25	14,810	10,470	Silver prints 1,324
General maps	23	8,930	5,874	Transfer prints ... 1,926
City and cantonment plans ...	69	14,418	5,040	Zincographic and anastatic
Miscellaneous maps, &c. ...	334	50,070	70,190	transfers 812
Proofs	...	1,131	...	Proofs 1,131
Totals for 1874 ...	1,280	1,57,600	1,53,242	
„ for 1873 ...	1,611	1,11,876	1,05,753	
Difference ...	−331	+45,724	+47,489	

42. The increase of work in printing alone is very great, nearly 32 per cent. above that of 1873; and to accomplish this immense out-turn of 1,53,242 complete copies of maps and other subjects by zinc printing alone, the strain on the small existing establishment has been very great throughout the year.

43. Complete details under each head connected with the several processes of photo-transfers, collotypes, silver-prints, &c., are given in the report of the Photographic branch in the Appendix.

Photo-collotypes.

44. The photo-collotype process has not yet been found to work sufficiently successfully for the reproduction of maps, owing chiefly to climatic influences, which necessitate various modifications in preparing and working the gelatine films during different seasons of the year. Experiments are still being made to endeavour to utilise this beautiful process for many other purposes, but for the printing of large maps requiring many sections to be joined together, it cannot be said to be adapted, or likely to answer.

45. A series of excellent plates have been produced from casts made from the caves of Cuttack, to illustrate Baboo Rajendralal Mitra's work on "The Antiquities of Orissa" ordered to be printed in this office by the Bengal Government, which bear ample proof to the value of the photo-collotype process for illustrations and delicate subjects of various kinds in which half tones or a variety of shades are desired or necessary.

Transit of Venus.

46. Captain Waterhouse's services were temporarily placed at the disposal of Colonel J. F. Tennant for the Transit of Venus observations at Roorki in November and December last, where he was most successful in securing a fine series of plates of the transit: 107 photographs on 6-inch plates were taken at intervals of 2 minutes during the progress of the transit, besides 5 circular plates of the three last contacts and two intersections taken in the Janssen apparatus, each circular plate comprising 60 separate pictures taken at intervals of about 1·21 minutes. A summary of the results of these experiments, and a full account of the operations at Roorki, are given in the memorandum attached to Captain Waterhouse's report in the Appendix. Similar photographs were taken at this office and 39 plates have been obtained of the Transit of Venus, in connection with a series of observations, with moderate size instruments, carefully reduced to Calcutta mean time.

Lithographic Branch.

47. The work required of this branch of the office, which has likewise been under the immediate superintendence of Captain Waterhouse, Assistant Surveyor-General, is shewn to be largely on the increase. The out-turn of work of different kinds performed during the year 1874, compared with that of the previous year, is as follows:—

	1873.	1874.	Increase.
New drawings on transfer paper	274	271	...
Ditto on stone	25	37	...
Color stones prepared	139	142	...
Subjects printed	481	602	121
Complete copies	1,59,652	2,14,153	54,501
Pulls	2,38,712	2,27,501	38,789
Sheets of Forms, &c., (type)	594	2,100	...
Complete copies	2,75,334	1,95,876	...
Pulls	3,80,693	3,28,583	...

Of the 2,14,153 complete copies of maps, plans, &c., printed during the year, 46,584 were the regular publications of this Department, the balance (1,67,569) were for various other Government Departments: 602 new subjects were dealt with, of which 220 were Departmental and 382 for other branches of the public service.

48. Chromo or color printing for tints, territorial boundaries, geological and forest conservancy, sanitary and vaccination report maps, &c., has been very successfully worked, and has proved an invaluable substitute, as far as it has gone, for the very tedious, expensive, and unsatisfactory process of coloring by hand; but, of course, a very large amount of coloring has still to be done by the latter method, owing to the vast rapidity of photozinco-printing.

49. The combined out-turn of the three different descriptions of printing presses is as per margin, which gives an increase of nearly 1,00,000 over that of the previous year.

	Number of complete maps.
Photo-zincographic	1,53,242
Lithographic	2,14,153
Copperplate	10,529
Total ...	3,77,924
Do. for 1873 ...	2,81,036
Increase ...	96,888

50. Experiments are now making to introduce the use of grained transfer paper for shaded chalk drawings applicable for rapid hill sketching, for miscellaneous maps, in the place of vertical hachuring or horizontal contouring, which is so tedious and frequently so unsatisfactory except done by a first-rate draftsman. Mr. Fraser Crawford's method of drawing lithographic transfers over photographic prints made with gelatine and brichromate of potash has been largely and successfully practised. By this process very accurate

copies or reductions of drawings or maps, charts and plans, which are unsuited for photozincography, can be obtained.

51. Details connected with all the work accomplished in the lithographic branch are given in Captain Waterhouse's report in the Appendix.

Office accommodation.

52. The arrangements in progress during the past year for the preparation of a suitable design for a new building to accommodate and combine the several detached branches of the Head Quarters offices, on the land purchased in Park and Wood Streets have not as yet resulted in any definite or finally approved plan and estimate, but the subject is now well in hand, and it is hoped that the Public Works Department will be in a position to break ground during the current year, and that the object may then be vigorously prosecuted to completion, as every day and month adds to the great difficulties and inconveniences at present existing for want of room, with heavy stock of records increasing in the ratio above described, and for which temporary provision has now been ordered to be carried out.

Re-organisation of the Department.

Revenue, Agriculture and Commerce Department, No. 812, dated 13th December 1873.

Financial Resolution No. 3235, dated 27th November 1873.

53. During the past year, a new system of consolidated salaries for the entire Department, and a re-organisation of the several grades of the Senior Branches, has been carried out with effect from the 1st April 1874, the commencof ment of the Financial year, under the orders e-Government specified in the margin.

Consolidated Salaries.

54. The revised strength and salaries of the administrative staff and graded officers is contained in the following statement, issued with departmental order No. $\frac{331}{125}$, dated 5th May 1874 :—

	Trigonometrical.	Topographical.	Revenue.	Total Number.	Sanctioned maximum salary of each.
ADMINISTRATIVE.					Rs.
Surveyor General	.....	1	.....	.....	3,000
1st Superintendent, Great Trigonometrical Survey	1	.....	.....	.....	2,500
2nd Superintendent of Survey and Deputy Surveyor General	.....	.....	1	.....	2,200
3rd Superintendent of Survey and Deputy Surveyor General	.....	.....	1	.....	2,000
Three Assistants Surveyor General (average Rs. 1,233)	.....	.....	.....	.....	3,700
EXECUTIVE.					
Deputy Superintendents, 1st Grade ...	2	1	3	6	1,600
Do. do. 2nd do. ...	4	2	5	11	1,300
Do. do. 3rd do. ...	6	3	6	15	1,000
Assistant Superintendents, 1st Grade ...	4	3	5	12	750
Do. do. 2nd do. ...	4	2	6	12	600
Do. do. 3rd do. ...	4	3*	4*	11	500
TOTAL ...	24	14*	29*	67	.....

Combined Departmental graded list.

55. The general lists of the Topographical and Revenue branches have been combined into one roster or cadre as regards the Assistant Superintendents for future amalgamation. The object of introducing consolidated salaries has been to assimilate civil with military incumbents, when holding like appointments, in accordance with the principle prevailing in the Public Works Department, and also in some measure to avoid the anomalies caused by military officers of higher rank holding junior positions. Engineer officers only receive military pay proper in addition to the salary of their grade.

Temporary absence of the Surveyor General.

56. The Surveyor General having been granted privilege leave for three months, to visit England on private affairs, was absent from the 9th May to the 5th August last, during which time Colonel J. T. Walker, R. E., Superintendent, Great Trigonometrical Survey, was appointed by Government to officiate as Surveyor General.

* Exclusive of two supernumeraries on probation for either branch.

57. With so large an establishment, and so many hands employed in the various branches of this Department, it would obviously be impossible to shew successful results every year, and those of a very extensive character, the real effect of which has yet to be realised and understood in comparision with what is derived in other countries with corresponding means, without really efficient and zealous aid and co-operation. I have always, therefore, felt a peculiar gratification in acknowledging and recording the good and zealous services of my surbordinates, more especially of the excellent executive officers and their staff, whose devotion to the cause of the great work on which we are all employed, and in which we all take so deep an interest, is worthy of all praise.

Services of officers.

58. The several officers named under the head of Executive Surveys, as well as the Assistants Surveyor General, Mr. James, Deputy Superintendent of Survey, and Captain Waterhouse, Assistant Superintendent, attached to the administrative staff at Head Quarters, I commend to the special notice of the Government of India, as continuing in the highest degree to merit the confidence I place in them for their zealous and valuable labors during the period under review.

59. During the past year the total issue of maps to all Public Departments on service and to agents for sale, were as follows :—

Issue and sale of maps.

	Copies.	*Value Rs.*
To Government officials *bonâ fide* on public service	29,774	37,425
„ Despatches to the Geographical Department, India Office, London ...	4,313	5,560
„ Agents for sale to the public and for local service issues	3,935	8,546
TOTAL ...	38,022	51,531

60. The sales effected by the several agents represent 3,198 copies of maps, the value of which, less commission, amounts to Rs. 4,084 annas 2 ; this sum, as soon as realised or paid by the agents, will be at once deposited in the Treasury as heretofore done. The sales of maps to private persons in India are so limited ; because everybody almost is in the Government service, and claim maps for official purposes free of charge.

61. All monies realised on Government account during the year 1874 (*vide* statement in Appendix) amounting to Rs. 5,324-13-4, have been lodged in the Treasury Branch, Bank of Bengal, and the receipts of the Bank have immediately been sent to the Comptroller General. No cash balances are retained by this Department.

Account sales.

62. A review in detail of the operations of each Executive establishment or Topographical Survey party follows.

EXECUTIVE ESTABLISHMENTS.

No. 1.—TOPOGRAPHICAL PARTY.

GWALIOR AND CENTRAL INDIA SURVEY.

63. In continuation of the work of the previous season, chiefly in Sindhia's territory, the operations of this party under the command of Captain Charles Strahan, R. E., with Lieutenant E. P. Leach, R. E., as Assistant Superintendent, as described in the programme given in paragraphs 68 and 69 of the Report for season 1872-73, were extended West of the meridian of 76° 30′ over portions of the Native States marginally named, in the vicinity of Jhalra Patan, East of the district of Neemuch, and between the parallels of 24° and 25°, the southern limit of this division survey.

Detached portions of Sindhia's territory (portions of the Oojein, Mundisore and Neemuch soubats or districts), Holkar's territory, portions of Tonk, Kotah, Jhalawar, Pertabgurh, Udeypore, Bhynsoragurh and Joura in the Central India and Rajputana Political Agencies.

64. The final topography completed covers an area of 2,783 square miles between latitudes 24° and 25° and longitudes 75° 30′ and 76° 30′, the greater portion of which has been rendered in standard sheets Nos. 57, 60, 61 and 71. The triangulation in advance of the detail survey has been extended over 4,080 square miles, embracing Neemuch, Mundesore, &c.

Strength of party and outturn.

	Triangulation square miles.	Final topography, square miles.
Captain Charles Strahan, R. E., Deputy Superintendent, 3rd grade, in charge.	4,080	
Mr. C. A. R. Scanlan, Assistant Surveyor, 1st grade ...		242
Lieutenant E. P. Leach, R. E., Assistant Superintendent, 3rd grade.		294
Mr. R. D. Farrell, Surveyor, 4th grade		363
„ W. J. Cornelius, Assistant Surveyor, 2nd grade		200
„ P. J. W. Doran, „ 2nd „		327
„ C. T. Templeton „ 3rd „		252
„ W. M. Kelly „ 4th „		143*
„ G. A. Knight „ 4th „		204
Sub-Surveyor Abdul Samud Khan		251
„ Joula Pershad		265
„ Abdul Gufar		242
„ Girdhari Lall		
Total square miles ...		2,783

* Also large scale plan of Jhalra Patan city.

Observations were taken at 83 stations, from which 508 points were fixed and 256 elevations determined trigonometrically, and well based on the series of the principal triangulation.

65. Captain Charles Strahan reports favorably of the results of the out-turn and of the test he applied to the work of the several plane-tablers, which I found during my inspection of the party to be the case. The season's fair mapping contrasts very favorably with that of former years, and meets my full approval.

Opinion on the season's out-turn.

66. These results are very satisfactory in every way, and are due to the good management of the party by Captain Charles Strahan, Deputy Superintendent in charge, and his energetic Assistant Superintendent, Lieutenant E. P. Leach, of whom the Deputy Superintendent reports in high terms of praise. Messrs. Farrell, Scanlan and Cornelius, Surveyor and Assistant Surveyors, worked well and rendered good aid both during the field and recess seasons.

67. The country surveyed in detail has already been described (*vide* paragraph 61 of the report for season 1872-73, and appendix therein referred to), and a full description of the ground triangulated during the season under review will be found in the Appendix of this report (Extracts from the Narrative Report by the officer in charge No. 1 party, and notes by Mr. C. R. Scanlan).

Programme for season 1874-75.

68. During the current season of 1874-75, the plan of operations laid down for the guidance of the party may be briefly described as the extension of the detail work or plane-tabling in a westerly direction from longitude 75° 15′, between the parallels of 24° and 25°, and the continuation of the triangulation in the same direction so as to cover the ground in Meywar, Pertabgurh, &c., in the western half of the square degree formed by the parallels of 24°—25° and meridians 74°—75°.

Inspection of party.

69. During the month of September, on return from three months' privilege leave, I inspected the party and had much satisfaction in observing the state of efficiency of every member composing it. The professional records and fair mapping were all well and creditably completed up to date, leaving no arrears of any kind. Various professional matters regarding the future working of the party, and ground to be gone over, were fully discussed and arranged with the executive officer. I have particular pleasure in noticing the absence of all complaints against the party in their intercourse with the people in these Native States.

70. In consequence of an experienced Assistant Superintendent being needed with No. 7 Rajputana Survey, owing to Captain George Strahan's temporary absence on duty connected with observations of the transit of Venus, and the transfer of Captain J. R. Wilmer, Assistant Superintendent, from No. 7 party to take the charge of No. 5 Bhopal and Malwa Survey, as approved by Government in letter marginally cited, Lieutenant E. P. Leach, R. E., was transferred from No. 1 to No. 7 Rajputana Survey, from the 28th October 1874, and his place was filled up by Lieutenant J. R. Hobday, appointed to the Survey Department as a Probationary Assistant Superintendent by the orders of Government marginally noted, and he joined on the 10th October 1874. No. 1 party has always proved an excellent training school, and has turned out some of the best men in the department. It continues to maintain its high reputation and co-operates very fully in the difficult task of training fresh hands, which is a severe tax on any Field Establishment.

Transfer of Assistant Superintendent.

Revenue, Agriculture and Commerce Department No. 673, dated 14th November 1874.

Revenue, Agriculture and Commerce Department No. 538, dated 11th September 1874.

71. The progress of the publication of the 1-inch Standard sheets of this Survey is shown on the annexed index map, which describes likewise the proposed limits of the operations in connection with the other Survey Parties working in its vicinity. The extent to which the survey may be carried eventually westwards in the Myhekanta and Palhanpoor country is at present uncertain, and is therefore not defined on the index map.

No. 2.—TOPOGRAPHICAL PARTY.

KHANDESH AND BOMBAY NATIVE STATES SURVEY.

72. Owing to the general weakness of the party which had only been resuscitated a short time, and the failure of health of the senior Surveyor (Mr. R. Chew) early in January, the complete execution of the programme for the season, as detailed in paragraph 81 of the last report, was not practicable, so far as the triangulation in advance of final survey was concerned; but the detail operations were fully and successfully carried out, and the topography of 2,285 square miles (inclusive of overlaps with other surveys) was obtained. Of triangulation, an area of only 1,000 square miles was completed on the Vindhia hills, by observations at 18 stations, from which 73 positions were determined: and the elevations of 68 points were trigonometrically obtained; also heights of 231 obligatory points, such as watersheds, passes, river beds, temples, masonry buildings, &c. The season's operations extended through portions of the States above marginally named within the Central India Agency.

Portions of Foreign (Holkar's) Nimar and Malwa (Sindhia's territory,) also of Barwani, Dhar, Dewas, the Bhomias or Bheel Chiefships of Jamnia, Hindola and Rajghur, and the British Pergunnah of Manpur, North and South of the Nerbudda river.

Strength of party and outturn of work.

		Final topography square miles.
F. B. Girdlestone, Esq., Deputy Superintendent, 3rd grade, in charge.	Triangulation 1,000 square miles and triangulation of ground for the plan of Mahesar city and environs.	
Mr. R. W. Chew, Surveyor 3rd grade, privilege leave for three months		
Mr. A. G. Wyatt, Surveyor, 4th grade	... ...	315
„ W. C. Barckley., Assistant Surveyor, 3rd grade	... ...	300
„ E. Graham „ 4th „	... ...	289
Sub-Surveyor Shaik Omer	... ...	310
„ Mr. Rozario	... ...	169
„ „ Holtham	... ...	122
„ Churamun Lall	... ...	301
„ Ganesh Waman	... ...	168
„ Keshun Waman	... ...	191
„ Abdul Rahim	... ...	58
„ Hyder Ali	... ...	61
	Total square miles ...	2,284

In addition to the above, the large scale (12 inches=1mile) survey of the city, fort and environs of Mahesar was completed, covering an area of 9 square miles, besides 328 miles of check traversing was run with the chain through certain parts of the season's topography.

73. A survey of the large and important city of Mahesar (Maheshwar) on the Nerbudda, the summer residence of the Maharaja Holkar, a very interesting description of which is given in the Appendix, page 34, of my last report, was surveyed on a scale of 12 inches=1 mile; and to test the accuracy of the general work performed by the plane-tablers during the season, chain traversing was run over 328 linear miles.

74. The Deputy Superintendent reports very favorably on the results of his examination of the topography completed, and the field and fair maps testify to the care with which all details have been represented. Vigilant supervision was exercised throughout the field season over each detached party, and each plane-tabler working in difficult ground in which trigonometrically fixed points were not easily visible, was made to chain distances or to traverse for all details. The amount of work completed, considering the strength of the party and the very difficult nature of the ground, is very good.

Opinion on the season's topography and general outturn of work.

75. In the Appendix (extract from the Narrative report of the officer in charge, No. 2 party) valuable and interesting geographical notes are given of the country visited during the season's operations, also a description of the ancient capital of Malwa (Mando) now in ruins, of several other large towns, and of the fort of Mahesar.

Description of country and geographical notes furnished by executive officer.

76. The fall of the river Nerbudda between the town of Mortakka and the village of Kheri has been carefully determined by points fixed in the river, in a total distance of 73½ miles, measured along the river; the difference of height is 147 feet, giving an average fall of nearly two feet in every mile between the places above named.

Fall of the Nerbudda river.

77. During the recess season, the work which devolved chiefly on the Deputy Superintendent and his small staff of European assistants was exceedingly heavy, but by good management all the professional records, computations and fair mapping were completed. Six standard sheets on the inch scale, plan of Mahesar city and environs, and the chart of triangulation for Degree sheets I and IV, scale 2 miles=1 inch, were completed and rendered to this office. The Deputy Superintendent reports that no arrears of any sort exist.

Recess duties.

78. Early in August this party was visited by myself. The inspection of the records of all the field and office work proved that they were in perfect order, and all the work well in hand. The arrangements for the ensuing field season which, owing to the physical difficulties of the country along the Sathpuras, needed careful consideration, were fully discussed and arranged with the Deputy Superintendent. Measures were also adopted to secure the co-operation of the Bombay Settlement authorities for the survey of the northern portion of the plains of Khandesh, in the same manner and on the same scale as the topographical operations which are progressing in the Nassick and Ahmednuggur Collectorates.

Inspection of party.

79. The party has again suffered much from the effects of malarious fever early in the season, and latterly the native establishment suffered from guinea-worm. Water is very scarce throughout the western portion of the Sathpoora hills, and the little that can be obtained is seldom pure or wholesome. The severe losses in European life reported last year (paragraph 83) has necessitated great caution in working in the unhealthy parts of the Sathpura hills at particular seasons, and I trust we may be more fortunate in future.

80. The Deputy Superintendent, Mr. F. B. Gridlestone, was compelled, owing to the state of his health from climatic influences, to obtain furlough to Europe; and Mr. Horst, the next senior Assistant Superintendent, was transferred to this party from No. 5 Bhopal and Malwa Survey in October. Mr. Girdlestone availed himself of his furlough from the 19th October 1874.* To increase the efficiency of the party, both in strength and training agency, Mr. D. Atkinson, Surveyor 2nd grade, and Mr. A. J. Wilson, Surveyor 4th grade, who were on duty at Head-quarters, were transferred to No. 2 Survey from the 1st September and 1st August 1874, respectively. Both these Surveyors possess considerable experience, and are desirable additions to this party.

Vide my letter to Government, Revenue, Agriculture and Commerce Department, No. 339F., dated 22nd September 1874.

81. The able and energetic manner in which Mr. F. B. Girdlestone has conducted the operations of this party since he started work in December 1871, cannot be too highly commended. His devotion to duty has ever been conspicuous, and the out-turn of work, *viz.*, 8,000 square miles of triangulation and 4,157 square miles of final topography in three years, in such very difficult ground, with agency chiefly trained by himself, testifies to his zeal and ability. During his absence, Mr. H. Horst, Assistant Superintendent, officiating now in charge, will, I have no doubt, fully maintain the efficiency of the party in all respects. He has a difficult task before him, owing to the increasing difficulties and insalubrity of the ground under survey, portions of which are uninhabited, and also in consequence of his having to work on two different systems and scales in the wild, hilly, and non-revenue-paying, as well as in the open revenue-paying portions of Khandesh, but I have every confidence in his well-proved experience and sound judgment.

Mr. Girdlestone's good services.

82. Mr. Girdlestone reports very favorably of the excellent services rendered both in the field and recess by Messrs. Wyatt and Barckley, and Sub-Surveyor Shaik Omer, who are deserving of commendation and honorable mention.

Services of subordinate staff.

83. For the current field season, the plan of operations is as follows: a strong detachment under Mr. D. Atkinson, Surveyor 2nd grade, will proceed to triangulate the ground north of the Nerbudda river in Allirajpur and Rewakanta, between the parallels of 22° and 22° 30′ and meridians of 74° and 75°. The usual 1-inch topographical work will be continued in the Sathpuras south of the parallel of 21° 45′ down to 21° 15′, below which the larger scale survey (2 inches to the mile), based on traversing, will be taken up for the plains of Khandesh, for the incorporation of the village boundaries from the old Bombay Revenue and Assessment survey, on the same system as is being pursued in the Poona and Nassik districts of the Bombay Presidency.

Programme for season 1874-75.

* Revenue, Agriculture and Commerce Department Notification No. 9, dated 5th January 1875.

84. The dangerously malarious tract in the Sathpura Hills cannot be entered before the end of January, and it has therefore been necessary to provide suitable work in the open country along the Taptee, in the plains of Khandesh, for the employment of the party in November, December and January. For this purpose, the Bombay local civil authorities were moved to advance the demarcations or fixing of the village triple-junction points in the talukas around Bhosawul, so as to admit of the prosecution of the detail survey from East, on the completed Central Provinces side, towards the West, with the view of filling up all the area between the Nerbudda and Taptee rivers according to the original intention.

85. The sphere of action of this party is described in the annexed index map, showing the portions of the Central India Political Agency, both North and South of the Nerbudda, together with the Native States of the Bombay Presidency lying between the Nerbudda and Taptee rivers, and the plains of Khandesh South of the latter. The sheets of the survey tinted pink on the Index Map are published.

No. 3.—TOPOGRAPHICAL PARTY.

CENTRAL PROVINCES AND VIZAGAPATAM AGENCY SURVEY.

86. Lieutenant T. H. Holdich, R. E., Assistant Superintendent, received charge of the party from Colonel G. H. Saxton, Deputy Superintendent, (who had obtained furlough* to Europe) on the 15th December 1873, after all necessary arrangements for the field season had been effected by the latter officer at the depôt station at Vizagapatam, and by the first week in January the several surveyors entered the ground to be occupied during the season, as the earliest safe date for such a country (*vide* paragraph 94, printed report, for season 1872-73).

Portions of the Madgul and Golgonda estates in the Vizagapatam Agency, and of the taluk of Rampa, district Rajamundry, Madras Presidency.

Strength of Party and Season's outturn.

Lieutenant T. H. Holdich, R. E., Assistant Superintendent, 1st grade, in charge.	Triangulation	1,800 Square miles.
	Topography.	
Mr. J. Harper, Surveyor, 3rd grade	172	Square miles.
„ J. A. May, ditto 4th „	187	„
„ F. Adams, ditto 4th „	189	„
„ T. E. Claudius, Assistant Surveyor 1st grade	220	„
„ W. F. Pettigrew ditto 2nd „	184	„
„ A. Cooper, ditto 3rd „	95	„
„ Geo. Vanderbeek ditto 4th „	123	„
„ Duncan Campbell, Sub-Surveyor	169	„
„ Donald Campbell ditto	59	„
„ Lall Singh ditto	30	„
TOTAL ...	1,428	square miles.

87. The season's final topography covers an area of 1,428 square miles in the estates or zemindaries of Madgul and Golgonda of the Vizagapatam Agency, and of the Rampa taluk of district Rajamundry. On the North and East it is in continuation of the work of the previous season, whilst on the South it closes on the old Topographical survey of the districts of Vizagapatam and Rajamundry, executed in the years 1821 to 1825. All this particularly wild and densely covered ground, is much infested by tigers, and the dread of these beasts is fast driving the wretched and almost helpless inhabitants out of some of the finest country in these parts. All the topography completed was tested by the officer in charge, who states that, as far as it came under his observations, it was undeniably good.

Topography completed.

88. The Triangulation in advance of Topography was started independently of that of former seasons from the sides of the Beder Longitudinal series, Great Trigonometrical Survey, Narakonda, H. S., to Bodanally, H. S., and Bodanally, H. S., to Devargunta, H. S., and was extended northwards to a little beyond the parallel of 18°45'; the limit on the East being about the meridian of 81°30', so as to establish a junction with the stations of the triangulation previously completed, and on the West closing on the work of the old Hyderabad topographical survey in the Upper Godavery talukas of Bhadrachellam, Cherla, and Albaka. The area Triangulated covers 1,800 square miles in the southern portion of the zemindaries of Bustar, the wildest and most inhospitable country imaginable. Observations were taken at 20 stations, from which 210 points and 118 elevations were determined.

Triangulation completed in advance of detail survey.

89. In executing this work, Lieutenant Holdich and his small advance party experienced unusual difficulties and hardships. The dread of tigers, the labor and difficulty of moving daily through trackless forests, the want of proper shelter, and the constant attacks of malarious fever from which the party suffered, to which was added the frequent desertion of carriers or porters employed for the conveyance of provisions and such scanty camp equipage as could be carried about in these jungles, and without which the party could not have existed, were sources of constant anxiety.

90. A very complete and interesting description of the country visited during the season is given in the appendix extracted from the Narrative Report of Lieutenant T. H. Holdich, R. E., Assistant Superintendent.

3rd February 1874.

Recess duties.

91. During the recess all the professional records and computations and the season's fair mapping were completed and rendered, and Lieutenant Holdich states that no arrears exist. I had fully hoped to visit this party after my inspections were concluded at Poona, but urgent duty compelled me to return to Calcutta in the month of August last. There is much in the constitution and arrangements of this party, which has been segregated for so very long a period from the rest of the Department, which I am anxious to see into and to alter, and which I hope may be done during the current year. In the meanwhile, I have directed the instrumental equipment of the party, in use for so many years, to be carefully inspected; old and worn out instruments to be returned into store and replaced by new, and all superfluous articles dispensed with, which I hope will prove advantageous.

92. During the long recess at Ootacamund, some of the senior assistants have been taken out for training in the use of the larger instruments and on triangulating, with the view to greater efficiency in such important parts of their duty.

Reduction of the scale of survey.

93. Owing to the increasing difficulties of the country remaining for survey (about 9,000 square miles) in the western wilds of the Bustar State and its dependent zemindaries, within the Central Provinces, the very unprofitable nature of the country, the serious risk to health and life in surveying such malarious tracts, and the expense of conducting survey operations in such ground on the standard scale of 1-inch to the mile, I considered it my duty to submit for the consideration and orders of Government, a proposal to reduce the scale of this survey to ½ inch, or 2 miles to the inch. This measure received the approval and sanction of Government;* the remainder of the ground in the south-east portion of the Central Provinces will therefore be completed on the ½-inch scale, and I have every reason to hope that all that now remains to be surveyed on this side will be accomplished perhaps during the next two seasons. More than a quarter of a century has already elapsed since the work of this party was first started in the Khond hills and Tributary States of Orissa, and nowhere in India has the country presented such obstacles to fair progress. The effects of the climate has left its mark on many members of this Department, who have cheerfully, season after season, returned to the country, and who now have a good prospect of a successful and speedy termination to their labors and trials in this inhospitable direction.

Opinion on the season's out-turn.

94. The work accomplished during a short field season, and under unusual and ever increasing difficulties, is fair; more could not be expected. The whole party has throughout the season suffered very severely from fever, and, but for the return to a Hill Station, it is doubtful whether any work at all could be performed with such reduced physical powers as are left to the European staff after a field season in these jungles. To the energetic action and excellent judgment of Lieutenant Holdich is due the credit of the season's work.

95. Messrs. May and Claudius rendered good and efficient aid both during the field and recess, and received favorable mention by Lieutenant Holdich.

96. Mr. Pettigrew, Assistant Surveyor, 2nd grade, owing to ill health, has obtained two years' medical leave to Europe from 30th December 1874, and Mr. Donald Campbell, Subsurveyor, was permitted to resign his appointment from the 1st October 1874. These vacancies in the party it has not been possible to fill as yet, and for the change in the system of survey it is not so necessary.

Programme for season 1874-75.

97. During the ensuing season the triangulation in advance of Topography will be undertaken by Lieutenant Holdich and his senior Surveyor, Mr. Harper,—the former completing the work, as far as practicable, south of the Indrawutty river, while the latter pushes on northwards.

98. The topography will be continued to the west of that of previous seasons so as to establish a junction with that completed in the Aheree zemindaree of the Chanda district, as well as with the Upper Godavery taluk by the old Hyderabad Topographical Survey, and on the completion of this remaining tract allotted to No. 3 party, as shown in the annexed index map of that survey, the whole of the zemindaries in the southern part of the Central Provinces as well as of the Vizagapatam Agency will have been provided for, and No. 3 party will then be available for other work elsewhere.

99. The index map shows what portion of this survey, covering an approximate area of 50,193 square miles (as stated in paragraphy 97 of last report), has been published on the 1-inch scale. The diversity of execution of the original maps over a period of a quarter of a century, together with fluctuations in the scales of survey at different times, has rendered it difficult to illustrate the publication of the maps in a clear and intelligible manner. The old records are being gradually re-drawn in this office for reproduction by photozincography according to our limited means and the exigencies of the executive field parties, but it is hoped that the whole series may be accomplished within a reasonable time, and my earnest attention is directed to this object. At present the sheets most urgently needed for local investigations are first taken in hand and published. The utilization and issue of our 1-inch surveys of Native and of British Non-regulation States and Districts is of very great importance, and for which we are entirely indebted to the modern invention of photographic reproduction by transfers to zinc.

* *Vide* Revenue, Agriculture and Commerce Department's letter No. 532, dated the 10th September 1874.

No. 4.—TOPOGRAPHICAL PARTY.

NORTH-EASTERN DIVISION, CENTRAL PROVINCES SURVEY.

100. Full effect was given to the programme detailed in paragraph 108, page 16, of the printed report for 1872-73, and the topography and triangulation were successfully conducted through the portions of the new acquisitions of the Rewah State, and the districts of Mandla, Balaghat, and Bilaspur of the Central Provinces, marginally noted, in continuation of the work of former seasons.

The western portion of pergunnah Singwara, taluk Sohagpur, of the Rewah State. Portions of the Tehsildaris of Mandla and Ramgarh, in District Mandla, and of the zemindaries of Surmi, Karangi, Pandaria and Bijaipur, in District Bilaspur, Central Provinces.

101. By the triangulation in advance of detail survey, an area of 1,600 square miles in the southern portion of Mandla was covered. Observations were taken at 58 stations, from which 277 points and 163 elevations were trigonometrically determined. Final topography for 2,419 square miles was obtained, and this was fully tested by traverses over 274 linear miles and examinations *in situ*. The forest reserves of Chauarighogar and Airi, in the Mandla district, covering 3,842 acres, were minutely surveyed on the large scale of 4 inches to the mile.

Strength of party and out-turn of work.

	Triangulation. 600 Square miles.	Final Topography. Square miles.
Lieutenant-Colonel G. C. Depree, Deputy Superintendent, 1st grade, in charge, assisted by Mr. Vanderputt, 3rd grade Surveyor		
Mr. G. A. McGill, Surveyor, 2nd grade		248
„ J. Vanderputt, „ 3rd „		159
„ A. James, Assistant Surveyor, 1st grade ...		275
„ J. A. Barker, ditto 2nd „ ...		235
„ J. H. Wilson, ditto 3rd „ ...		297
„ G. Read, ditto 4th „ ...		31
„ G. L. Fleming, ditto 4th „ ...		138
Sub-Surveyor, Dutt, ...		265
„ Eusuf Shariff		336
„ Imam Shariff		226
„ Shere Shah		156
„ Atma Singh		53
TOTAL ...		2,419

This includes 37·5 square miles of overlap survey and the large scale (4 inches = 1 mile) surveys of the Forest reserves of Chauarighogar and Airi = 3,812 acres.

102. A good junction was effected, by means of triangulation, with the revenue survey village tri-junction masonry platforms in the districts of Bilaspur and Raipur. In the Mandla district the tri-junction points of villages fixed at the time of the assessment survey were found marked by a pile of stones and poles; all these were fixed and are shown on the season's maps, as such information may hereafter prove very valuable aids to future revenue or settlement surveys.

103. The country visited during the season throughout Mandla and down to the limits of the Balaghat district was precisely of the same bad nature as has already been described in the reports of previous seasons. All the hill ranges are elevated plateaux covered with heavy forest, and the entire surface of the ground is stony, presenting great difficulties for transit in any direction.

104. The Deputy Superintendent states that all the topography executed is minutely accurate. A considerable amount of traversing was performed by each plane-tabler in tracing up the details of ground features.

Recess duties. Fair mapping, &c.

105. During the recess, six standard maps from the results of the season's survey were completed and rendered, and, in addition, four standard sheets of the old Ganjam and Orissa and Chota Nagpore Topographical surveys were re-drawn by this Party. The half-degree chart No. IV. of Triangulation was also completed. The usual records of observations and all professional computations and registers were completed up to date. The Deputy Superintendent reports that no arrears of any kind exist in his office.

Inspection of Party.

106. The Party was inspected by myself in September last, and I had every reason to be satisfied with the quality of the work performed both in the Field and Recess. The excellent state of all the records and the means adopted by the Deputy Superintendent, Lieutenant-Colonel G. C. Depree, to maintain the efficiency of the party in all respects, was very gratifying. Ample evidence was placed before me of the accurate manner in which all the field work of the party is performed under Lieutenant-Colonel Depree's judicious and vigilant supervision.

107. Messrs. G. A. McGill and J. Vanderputt, Surveyors, are favorably mentioned by the Deputy Superintendent, who also reports well of the zeal of all his assistants. The health of Mr. George Read, Probationary 4th Grade Assistant Surveyor, having failed shortly after he was detached on field work, and having been medically reported as unfit for such hard work, he was permitted to resign his appointment from the 6th May 1874.

Programme for the season 1874-75.

108. In continuation of the topography completed during the season under review, the detail operations will be extended towards the south-eastern portion of the Mandla District as far as to the limits of the Seonee district already surveyed, and northern portion of District Balaghat, also into the States of Pandarha and Kawardha in Raipur. Some of the forest reserves in

Mandla and Balaghat will also be surveyed on the scale of 4 inches. Of triangulation in advance of details, only 500 square miles remain for completion in the district Balaghat to connect with the revenue surveys of the Central Provinces; this will be dealt with in due course during the now current field season. The filling up of the topography of this unknown and very wretched tract of country will take another season or two, when the party will be available for other work elsewhere. With this the Central Provinces will have been entirely completed, both as regards topographical and revenue surveys.

109. The index map of this party annexed shows the progress of these operations, and the area remaining to be executed, which, when completed, will embrace all the wild and unprofitable tracts between the Regulation districts of Bengal and Jubbulpore. The sheets published are also specified.

No. 5.—TOPOGRAPHICAL PARTY,

BHOPAL AND MALWA NATIVE STATES SURVEY.

110. It was arranged (*vide* para. 125 of the last printed report) that the topography of the western half of Degree Sheet III and the north-eastern section of Degree Sheet V immediately north of the Nerbudda in the Bhopal territory and above the station of Hooshungabad, should be completed; while the triangulation in advance of topography was advanced to the west and south of the work of former seasons.

Part of Bhopal in the Nizamuts of Duraha, Raisen, and Kalliakhera, with detached portions of the sonbhats or districts of Augur and Shajehanpur, in Sindhia's territory and a small portion of Holkar's territory; portions of Tonk, Rajgarh, Nursingarh, Maksudangarh or Naia Killa.

111. This programme was fully carried out under Captain Riddell's superintendence, and the final survey of the country round Bhopal and Sehore between the meridians of 77° and 77° 30′, and the parallels of 23° and 24°, together with the portion further south between the meridians of 77° 30′ and 78° and the parallels of 22° 45′ and 23°, embracing portions of the Native States above marginally noted in the Rajputana and Central India Agencies, covering an area of 2,812 square miles, was completed, and the triangulation was extended over an area of 2,883 square miles. Observations were taken at 57 stations and 491 positions and 659 elevations were trigonometrically determined; of these, 281 were within the triangulation of previous seasons, and were dependent on distances measured on the plane table field sections, and the triangulation for a large scale plan of the city of Sehore, the Head-quarters of the Bhopal Ageney, was completed.

Strength of party and season's out-turn.

		Triangulation.	
Captain R. V. Riddell, R. E., Deputy Superintendent, 3rd grade, officiating 2nd grade, in charge	...	961	square miles.
H. Horst, Esq., Assistant Superintendent, 1st grade	...	1,872	„
TOTAL	...	2,833	square miles.
		Topography.	
Mr. C. F. Hamer, Assistant Surveyor, 1st grade	...	301	square miles.
„ E. A. Wainwright „ 2nd „	...	231	„
„ H. Kitchen „ 3rd „	...	318	„
„ W. H. Lilley „ 3rd „	...	323	„
„ J. Murray, Assistant Surveyor, 4th grade	...	225	„
„ A. Kitchen „ „	...	222	„
„ T. Downes „ „	...	219	„
„ G. R. Copping „ „	...	273	„
Sub-Surveyor Prem Raj	...	270	„
„ Abdul Rahim	...	246	„
„ Goburdhun	...	100	„
„ Mowla Bux	...	54	„
TOTAL	...	2,812	square miles.

112. In addition to the above, test lines were run by the Executive Officer, the Assistant Superintendent, and the Senior Surveyor attached to the party, through the detail work of each plane tabler, together with the usual examination *in situ* during the progress of the field sketching, from which it appears that all the topography obtained is reliable, and the features of the country fairly delineated.

113. This outturn for a field season of about six months' duration is very good, and is sufficient evidence of the energy and excellent management which has always characterised every duty entrusted to the Deputy Superintendent in charge, Captain R. V. Riddell, R. E., who conducted the duties up to the 15th September last, when he was granted three months' privilege leave, and subsequently directed to do duty at Head-quarters temporarily, in consequence of a very severe accident to his eye, which I much regret prevents his taking the field during the current season, and will necessitate his applying for furlough to Europe immediately. Captain Riddell's loss from executive management is much regretted, and I express a hope that he may be able to return to the department where his services are highly appreciated.

Opinion on the season's outturn.

114. The Assistant Superintendent, Mr. H. Horst, as usual, rendered good aid in the field, and his assistance receives due acknowledgment from Captain Riddell.

115. During the recess the usual professional computations, original and duplicate, were completed, together with the fair drawing of six, 1-inch scale standard sheets, Nos. 11, 13, 15, 17, 26, 28, and the triangulation chart of Degree Sheet III. These sheets have been rendered to this office and have been re-produced for issue. All the mapping of this party is rendered in excellent style, and shows a very satisfactory state of progress.

Recess duties.

116. I was much satisfied during my inspection of the party, both in the field in the Bhopal State, as well as in the recess subsequently, with its state of efficiency and the good management displayed both in the field and recess, of all details by the Deputy Superintendent. The standard fair maps are excellent, evincing much improvement over former years and admirably suited for immediate reproduction. All the computations and records were well arranged and in good condition, and no arrears of any description of work existed in the office.

Inspection of Party.

117. Captain Riddell reports favorably of the services of the assistants under his command, all of whom have well performed the duties entrusted to them, both in the field and recess.

118. The programme for the current season is as follows,—The final topography of the North-East quarter of Degree Sheet IV and the north-west quarter of Degree Sheet V or Standard Sheets 18, 20 of Rajgurh, with 27 and 29 of Bhopal, to be completed. The triangulation in advance of details to be extended so as to cover all the ground between the meridians of 75° 30′ and 76,° and from latitude 22° 50′ to 24° so as to embrace the country round Mhow and Indore, which is of greater importance, and has been urgently called for by the Political authorities, and if time permits, to be further advanced east of the meridian of 76° so as to cover a portion of the southern half of Degree Sheet V, subtending the Nerbudda river. The general direction of these operations is between 24° and 22° parallels from east to west, through Indore, Amjhera, Oojein, Mundesore, Rutlam, Partabghar, Banswarra and Jabooah, including parts of Mahikanta, of Rewakanta, Pahlanpur, &c., in the Bombay Presidency, as described in the Index Map of this division attached.

Programme for season 1874-75.

119. To give effect to this programme will be the duty of Captain J. R. Wilmer, Assistant Superintendent, 1st grade, who has been placed in charge of the party, as reported to Government in my letter. Captain Wilmer was for several years the Assistant Superintendent in No. 5 Party, and has a good knowledge of the country in which he has now to operate. He is a most efficient officer of several years' experience in the Department, and will do ample justice to the work.

Charge of Executive Officers.

No. 501 F, dated 29th October 1874.

120. Mr. Horst, Assistant Superintendent, was towards the close of the recess season transferred to the charge of No. 2 Khandesh Topographical Survey for the reasons already given in my review on the operations of that party. In consequence of the pressing necessity of Mr. Horst relieving Mr. Girdlestone at Poona, the current duties of No. 5 Party were well performed by Lieutenant Leach, R. E., Assistant Superintendent, who happened to be on the spot, and was of the utmost assistance when Captain Riddell was incapacitated, and until the arrival of Captain Wilmer from Simla.

121. In the Appendix extracts are given from Captain Riddell's narrative report descriptive of the country throuh which the season's operations passed.

No. 6.—TOPOGRAPHICAL PARTY.

KHASIA, GARO AND NAGA HILLS SURVEY.

122. For reasons which have been fully explained in the reports of two previous seasons (1871-72 and 1872-73) the work of this party continues to partake of the character of a good and reliable geographical reconnoissance and explorations on a reduced scale, based on triangulation, along the North-Eastern Frontier and in the Manipur State; and, as described in paragraphs 141 to 145 of the last report, three distinct detachments were formed with the object—*1st*, of continuing the exploration in the Eastern Naga hills, south of Seebsagur and Lakhimpur districts; *2ndly*, the completion of the central portion of the "Naga hills or Samagooting district;" and *3rd*, to fill up the blank or western portion of the Manipur Native State between the meridians of 93° 15′ and 94°.

The Garo hills, Western portion, Naga hills district, central portion, continuation of the Naga Hills and of the Manipur Native State.

Strength of party and season's out-turn.

	Triangulation in square miles.	Topography completed. Scale, 2 miles =1 inch.	Topography completed. Scale, 4 miles =1 inch.
Captain W. F. Badgley, Officiating Deputy Superintendent, 3rd grade, in charge	800	...	2,294
Lieutenant R. G. Woodthorpe, R. E., Assistant Superintendent		1,153	...
Mr. M. J. Ogle, Surveyor, 4th grade	2,300	146	694
„ A. W. Chennell, Assistant Surveyor, 1st grade ...	...	1,068	...
„ W. Robert, ditto ditto, 3rd ditto ...	...	1,130	...
„ J. McCay, ditto ditto, ditto ...	...	931	...
Sub-Surveyor Shah Nasirudin	...	708	...
Ditto Daliludin	...	299	...
Ditto Moung Hay	...	779	...
		6,213	2,988
TOTAL ...	3,100	9,201	
MARGINS AND OVER-LAPS ...		Sqr. miles 1,590	

123. These objects were fully attained, the

only exception being the non-completion of a small strip of country in the Naga Hills district running parallel with the Doyang river for a distance of about 25 miles, and the season's topography fills up several blanks between the work of previous seasons which were unavoidable, owing to the special and detached nature of the previous explorations connected with the military expeditions on the Frontier.

Season's outturn.

124. The total outturn of Topography thus rapidly obtained over a most difficult tract of inhospitable hilly country covers 9,201 square miles, of which 6,213 square miles were on the reduced scale of 2 miles to the inch, and 2,988 square miles on the still smaller scale of 4 miles to the inch, inclusive of 1,590 square miles of margins and over-laps along the limits of previous survey. Captain Badgley, Deputy Superintendent in charge, reports that all the work thus completed is very good and quite sufficient on the scales mentioned for the purposes intended of such peculiar description of country of so little value and so impenetrable. The ground in the central portion of the Naga Hills district was low and covered with dense forest, most difficult of access and accomplishment.

Triangulation.

125. The season's triangulation covers an area of 800 square miles in the Naga Hills, and 2,500 square miles in the Native State of Manipur; total 3,100 square miles. Observations were taken at 18 stations, from which 90 positions and 48 elevations were determined.

Opinion on the season's results.

126. The difficulties encountered by the whole party were very trying, and many and great privations, as regards food and proper shelter, were experienced throughout the season, yet every member zealously performed his share of duty and thus contributed to a very successful season's outturn.

Course of the Lanier river.

127. A considerable portion of the country visited and mapped was totally unknown, except by name, to our oldest and most experienced Frontier officers, and the Lanier river, which has long been supposed to be a branch of the Doyang draining into the Brahmaputra, has been proved to be one of the tributaries of the Namtonai or Kyandwein river which takes its rise in the Hookoong valley in Northern Burmah and joins the Great Irawadi river about latitude 21° 35′, longitude 95° 10′, almost due west of Ava.

128. The Lanier river (Lang-tang-khong of the Manipuris) takes its rise to the west of the well known peak in Manipur of Shiruifirar ($\frac{\text{latitude } 25°\ 6'\ 14''}{\text{longitude } 94°\ 30'\ 9''}$) estimated height 8,266 feet above sea (*vide* Yule's Map of Burmah, London, 1857) and flows thence in a north-easterly direction for 44 miles to the Naga village of Thetchunasa, where it suddenly turns off at a right angle in a south-easterly course and breaks through the high range on which the great snow-clad Saramethi peak (elevation 12,622 above sea level $_{\text{longitude } 93°\ 4'\ 41''}^{\text{latitude } 25°\ 44'\ 22''}$) is situated (about 15 miles south-west of the peak) joining, it is believed, the river named Numpugna on Wilcox's map of the sources of the Brahmaputra and Irawadi rivers, 1828.

129. The country visited by the exploring party under Captain Badgley is inhabited by various Naga tribes, *viz.*, "Angamies," "Semas," "Rengmas," "Lotas" and "Naked Nagas," and most of it is well populated. It is throughout hilly, and the inhabitants do not take kindly to the intrusion of strangers, which adds greatly to the difficulty of survey operations. Very interesting details connected with the season's survey are given in the Appendix: *vide* extracts from the narrative report of Captain W. F. Badgley, Deputy Superintendent in charge of No. 6 Topographical Survey. See also "Report on the Exploration Survey of the Naga hills by Captain John Butler, Officiating Political Agent, Naga Hills," published by the Chief Commissioner, Assam, 1874.

Services of Captain Badgley and party acknowledged.

130. It affords me great pleasure to bring prominently to the notice of Government the continued good services which Captain Badgley and his small party have again rendered on the Eastern Frontier. Life and health have been freely risked, orders have been cheerfully obeyed under very trying circumstances, and without exception every member of the party has been actuated by the one feeling of striving to do his utmost in the interests of Government and for the credit of the Department. More or less, the whole party has suffered much from the effects of bad and insufficient food, fever, and from complaints brought on from exposure during very inclement weather in low pestiferous valleys, and also in the higher hills (often snow-covered) in the Eastern Naga Hills. Eight of the native establishment died from cholera and dysentery.

131. Captain Badgley throughout the season took a leading share in the season's operations, and has well maintained his reputation as a pioneer in the interests of geography. He was well and ably seconded by Lieutenant R. G. Woodthorpe, R. E., Assistant Superintendent, whose zeal, energy, and well-directed aid contributed much to the season's outturn.

132. Messrs. M. J. Ogle, A. W. Chennell, and W. Robert rendered excellent service: Mr. Ogle in particular, to whom was entrusted the work in Munipur, and who was for the whole season completely isolated with his small detachment from the rest of the party, did exceedingly well and did not leave his ground, though it was late in the season and bad weather had set in, until the completion of every portion of the work entrusted to him. Mr. Ogle is a most valuable assistant, to whom the highest credit is due.

133. The work during the recess was heavy, but all the professional records and computations were completed and the fair mapping (15 sheets 1-inch scale), with the exception of 4 sheets containing large blanks still remaining for survey, were finished and rendered to this office. The mapping of this party is well executed, and fairly represents the wild and mountainous nature of the country along the Frontier.

Recess duties.

134. During the now current season of 1875-76 the party is again employed in three separate detachments. By the return of Major H. H. Godwin-Austen from furlough* a strong party was formed to accompany the military expedition against the Duffla tribe on the Northern Frontier of Assam: this detachment, as per margin, will explore as much of the hills along the northern frontier as can be visited either under military protection or political aid. Under the able direction of Major Godwin-Austen, who has had such extensive experience in this sort of military exploration of totally unknown countries, great expectations are formed of the probable results of the season's work, and when the Duffla hills are evacuated by the British force, it is hoped that the remaining Northern Frontier of Lakhimpur along the other friendly hill tribes' border may be visited and mapped in connection with our triangulation up the valley of Assam, and the revenue survey already completed to the north of the Brahmaputra.

Future operations.

* Returned 27th October 1874.

Major H. H. Godwin-Austen, Deputy Superintendent, in charge.
Lieutenant J. Harman, R. E., Assistant Superintendent, Great Trigonometrical Survey.
Mr. M. J. Ogle, Surveyor.
„ W. Robert, Assistant Surveyor.

135. The *second* detachment under Captain Badgley, assisted by Mr. Channell, and the *third* under Lieutenant R. G. Woodthorpe, R. E., assisted by Mr. McCay, will continue the exploration and survey of the Eastern Naga Hills, south of the Sibsagar District, on the reduced geographical scale. By these means it is expected that a very sensible impression will be made on the hitherto unknown hill tracts north and south of the Assam valley, and by the extension of the triangulation along the frontier, that we shall hereafter be able to continue our exploratory surveys to the Eastern head or limit of the Assam valley, touching on Tibet, China, and Burma, of which there is much still remaining to be done.

136. The index map attached shows the large area already accomplished, and the probable extent of the country remaining to be taken up.

No. 7, TOPOGRAPHICAL PARTY.

RAJPUTANA AND SIMLA SURVEY.

137. Full effect was given to the programme for the season under review, as detailed in paragraph 158 of the last report; the triangulation in advance was extended through the greater portions of Degree Sheets IX and X, embracing Ajmere and Jodhpur or Marwar and well connected to the east with the sides of the Gurhagurh Series Great Trigonometrical Survey in Jeypur territory. An area of 5,210 square miles was thus covered by observations at 57 stations; 567 points were fixed, and 316 elevations determined.

Portions of District Ajmere and Mhairwarra and of the Native States of Udeypur, Marwar or Jodhpur and Kishengurh.

Strength of Party and season's out-turn.	Triangulation. Square miles.
Captain George Strahan, R. E., Deputy Superintendent, 2nd grade, in charge	2,160
„ J. R. Wilmer ... Assistant „ 1st „	3,050
Total Triangulation ...	5,210

	Topography. Square miles.
Mr. E. S. P. Atkinson, Surveyor, 4th grade	345
„ R. Todd, Assistant „ 1st „	135
„ C. Tapsell „ „ 1st „	335
„ F. Kitchen „ „ 1st „	270
„ W. Statesbury „ „ 1st „	475
„ W. W. McNair „ „ 2nd „	270
„ F. Warde „ „ 3rd „	460
„ P. White „ „ 4th „	270
Sub-Surveyor Mr. J. Noah	270
„ Kalka Pershad	340
Total ...	3,170

138. The final topography of 3,170 square miles in Mhairwarra, parts of Udeypoor and Jodhpur, was completed and tested by 95 linear miles of test routes. Large scale plans (12 inches = 1 mile) of the cantonments of Erinpura and Beawar were also completed. The Deputy Superintendent reports that all this work has been well and carefully executed.

Check routes 95 linear miles. Triangulation for the large scale plans of Beawar and Nasirabad by Captain George Strahan and Captain Wilmer. Plan of Erinpura Cantonment (scale 12 inches = 1 mile) by Mr. F. Kitchen and of Beawar or Nyanagar by Sub-Surveyor Kalkapershad.

139. The triangulation was extended by a series of 1st class secondary triangles northwards from the city of Jodhpur to latitude 27°, and then running east along this parallel was connected with the Gurahagurh series on about the meridian of 75°,—a net work of triangulation was

Description of the country.

then thrown over nearly the whole of Degree Sheet IX or from about latitude 26° to 27°, longitude 74° 10′ to 75°. All the northern portion of this ground is described by Captain George Strahan, R. E., Deputy Superintendent, as difficult for triangulation, being a flat plain with occasional groups of sand-hills rising from 80 to 100 feet above the general level of the country. No rivers or water-courses were met with, water was scarce and brackish and found only in wells at a great depth. Marching over the ground was tedious and very fatiguing owing to the depth of the sand, and from its being extensively undermined by rats; supplies and grass for horses were scarce and only obtainable with difficulty from long distances.

Simla and Jutog Survey.

140. The party having closed satisfactorily the Rajputana work, returned to recess quarters early, in order to take up the Simla and Jutog large scale survey (24 inches = 1 mile, or natural scale $\frac{1}{2640}$) prior to the heavy rains, and was again employed on the same work in September and October, so as to ensure the completion of the field work, which was most satisfactorily effected before proceeding to the distant scene of operations in Rajputana for the now current season.

141. All that now remains to be done is the insertion of the boundaries of estates, regarding which, in some cases, the local civil authorities and municipality have not yet succeeded in arriving at any final decision. As fast as the investigation of disputed and doubtful boundaries is completed and final decisions arrived at, the boundaries will be inserted on a second edition of the photographed sheet plans: the survey preliminary plans as reproduced on so large a scale are a great help to the adjustment of all disputes and outstanding uncertainties.

General reduced plan of Simla and Jutog.

142. In addition to the excellent and elaborate large scale sheet plans, 20 in number, for the Simla survey, Captain George Strahan has completed and rendered a most artistic general plan of Simla and Jutog in brush shading, on a scale of 8 inches to the mile, or natural scale $\frac{1}{7920}$ (or one-third of the original scale), which will be invaluable both to the permanent residents and visitors to Simla as a guide or hand map for easy reference. This map will be published in the best possible style as soon as possible.

Details connected with the Simla and Jutog survey.

143. The labor imposed on the party by this hill survey may be reckoned from the following details: 67 linear miles of traversing on 24 inches = 1 mile along roads; 502 points and 277 elevations trigonometrically determined; field sketching on 24 inches of 19·03 square miles or 12312·3 acres of hills. It is a matter of congratulation that the double object of the survey in the plains, together with the laborious large scale survey of the hill sanitarium, has thus been successfully and efficiently accomplished. An admirable outturn has been effected in both cases at a most moderate cost.

144. An immense amount of drawing has been accomplished on the unusually large scale of 24 inches to the mile, which could not have been accomplished except by very superior management and the most indefatigable exertions of all concerned.

Recess work.

145. All the professional records and computations in duplicate and all the fair mapping, which was exceedingly heavy in consequence of the large area completed in Rajputana in addition to the Simla and Jutog sheets,* has been completed and rendered in excellent style. All the mapping is well and carefully executed, and is most creditable to the party.

* Fair standard sheets Rajputana survey 1-inch = 1 mile, Nos. 43, 50, 51, 52, 53, 65, 69.
Triangulation chart degree sheet VIII.
Plans of Erinpura and Beawar or Nyanaggar.
Simla and Jutog sheets 24 inches = 1 mile, Nos. 13 to 18 inclusive.
Simla and Jutog brush-shaded completed map, scale 8 inches = 1 mile.

Opinion on the season's results.

146. The outturn of the season is very good and most creditable to the officer in charge, his Assistant, Superintendent Captain Wilmer, and the surveyors and assistants, all of whom have exerted themselves to the utmost to maintain the credit of the party, both as regards the quality and quantity of the work performed. The office was frequently inspected by myself at Simla, and full advantage taken of constant personal communication for the conduct of the work in advance.

147. Captain George Strahan, Deputy Superintendent in charge, continues to take a leading share in every duty connected with the season's work, and is indefatigable in his exertions to maintain the highest efficiency by imparting careful instruction to every assistant in all professional duties, both in the field and recess season. Great credit is due to Captain George Strahan for his excellent services.

148. Captain J. R. Wilmer, Assistant Superintendent, rendered excellent aid both in the field and recess, and Captain George Strahan testifies in very complimentary terms to this officer's qualifications. Captain Wilmer has now been entrusted with the charge of No. 5 Party, to which he will do ample justice. Mr. W. W. McNair has as usual rendered good aid, and is specially distinguished by the Deputy Superintendent in his report, not only for the important part he took in the season's work, but also for his contribution to the archæological history of the places he visited. His description of the Ranpur Temple in the Aravalli Range is given in the Appendix. Messrs. Atkinson, Todd, Kitchen, Tapsell and Stotesbury are also deservedly favorably mentioned.

Change of Assistant Superintendent.

149. Captain George Strahan's services being urgently required temporarily for the Transit of Venus observation at Lahore, was deputed in November last accordingly to place himself under the orders of Colonel Tennant, R. E., for the purpose, and after the completion of the duty rejoined at Ajmere on the 27th of December 1874, in good time to conduct the season's work. Captain Wilmer, Assistant Superintendent, having been necessarily appointed to be the officer in charge of No. 5 Party, Bhopal and Malwa Survey, Lieutenant E. P. Leach, R. E., was transferred to this party from No. 1, Gwalior and Central India Survey, and joined it at Simla on the 21st October 1874. He conducted the party into the field and started the season's operations in Rajputana according to the programme laid down, and under the instructions of Captain George Strahan. Lieutenant Leach also did excellent service with No. 5 Party, temporarily during the recess at Mussoorie, when Captain Riddell was incapacitated by his accident, and my cordial acknowledgments are due to Lieutenant Leach for his successful exertions.

Programme for season 1874-75.

150. During the current season, the triangulation in advance of details will be extended northwards into Degree Sheets XI and XII, through the Jodhpur State into Bikanir. The final topography will be taken in hand of the Western and Southern portions of Degree Sheet IX, containing nearly all the British District of Ajmere and a portion (Eastern) of the Jodhpur Native State. The index map attached shows the present direction the operations are taking, as well as the area completed since the last index was published with the Annual Report of 1869-70.

151. During the ensuing recess months the survey and introduction of the boundaries of estates in Simla, on the plans, will be advanced as far as possible, and the approaches to Simla from the north and east as far as Mahasu will be taken up on the scale of 6 inches=1 mile and continued south, with the view of connecting the surveys of the several Military Cantonments of Dugshai, Subathoo, and Kussowlie, and their several approaches, which will be laid down as time permits, on convenient scales, according to the original programme.

H. L. THUILLIER, *Colonel,*
Surveyor General of India.

SURVEYOR GENERAL'S OFFICE,
CALCUTTA,
15*th January* 1875.

APPENDIX.

Statement A

Showing progress and cost of each Survey during season 1873-74, *with general average mileage rates.*

Designation of Survey.	Final topography completed, square miles.	Triangulation completed, square miles.	Stations observed at.	Number of points fixed.	Square miles to each point.	Heights trigonometrically determined.	Square miles to each height.	Amount of fair mapping received.	Total cost of Survey.	Remarks.
No. 1 Survey, Gwalior and Central India	2,783	4,030	83	568	7·2	319	13·2	2,163	59,633	
No. 2 Survey, Khandesh and Bombay Native States ...	2,234	3,000	18	75	13·7	361	6·8	2,203	51,333	
No. 3 Survey, Central Provinces and Vizagapatam Agency ...	1,128	1,900	20	210	5·6	118	15·3	3,205	58,065	
No. 4 Survey, North-Eastern Division, Central Provinces ...	2,125	1,000	55	277	5·8	163	9·8	2,271	60,921*	* Includes cost of two Forest Reserve Surveys on 4 inches=1 mile.
No. 5 Survey, Bhopal and Malwa	2,312	2,633	57	491†	5·8	650	4·3	2,723	69,638	† Include heights determined from bases taken from plane table survey.
No. 6 urvey, Khasia, Garo and Naga Hills	9,201	3,100‡	18	90	34·4	48	64·6	6,662	61,041	‡ 0213 square miles on scale 2 miles=1 inch; 2983 square mile on scale 4 miles=1 inch.
No. 7 Survey, Rajputana ...	3,170	5,210	52	667	9·2	316	16·5	3,781	73,319§	§ Includes cost of the survey of Simla and Jutog.
Total ...	24,103	19,623	311	2,376	8·7	1,965	9·9	21,383	425,011	General average mileage rate, 17·49·2 per square mile.

Statement B.

Professional results and value of the Season's Triangulation and average No. of Plane Table fixings of Detail Survey, Season 1873-74.

Surveys.	Number of Triangles.				Triangular error in seconds.		Mean difference in common sides in inches per mile.				Average plane table fixings in each square mile of survey.	Remarks.
	1st class.	2nd class.	3rd class.	4th class.	1st class.	2nd class.	1st class.	2nd class.	3rd class.	4th class.		
No. 1 ...	...	142	58	910	...	4·5	1·20	1·68	5·64	...	9·8	
„ 2 ...	3	55	...	173	2·8	11·75	..	5·4	...	16·4	8·1	
„ 3 ...	...	39	21	311	...	7·2	...	2·76	2·64	9·0	6·5	
„ 4 ...	...	52	56	363	...	4·9	...	7·9	7·3	14·9	8·9	
„ 5 ...	...	140	1,030	...	...	9·1	...	1·51	4·1	...	9·6	
„ ...	11	4	3	424	3·1	6·7	3·4	1·1	...	27·6	0·35*	* Military reconnaissance and explorations on 2 and 4 miles to the inch.
„ 7 ...	11	102	...	1,313	1·01	5·3	...	2·1	9·1	...	6·48	
Total ...	25	543	1,168	2,907	2·39	6·9	2·35	3·21	5·76	17·0	6·9	

APPENDIX.

STATEMENT C.

Comparative results and costs of Seasons 1872-73 *and* 1873-74.

	Final topography, square miles.	Triangulation, square miles.	No. of Stations observed at.	No. of points fixed trigonometrically.	Heights determined trigonometrically.	Cost.	Rate per square mile.	Remarks.
						Rs.	Rs. A. P.	
Season 1872-73	25,327	18,930	379	1,885	1,365	449,896	17 12 0	Includes cost of the Simla and Jutog Survey and of several cantonments, towns, and forts on large scales.
,, 1873-74	24,103	19,623	311	2,276	1,965	425,041	17 10 2	
	−1,224	+693	−68	+391	+600	−24,855	−0 1 10	

No. 1 PARTY

INDEX TO THE SHEETS OF THE GWALIOR & CENTRAL INDIA TOPOGRAPHICAL SURVEY.

On the Scale of 1 Inch = 1 Mile.

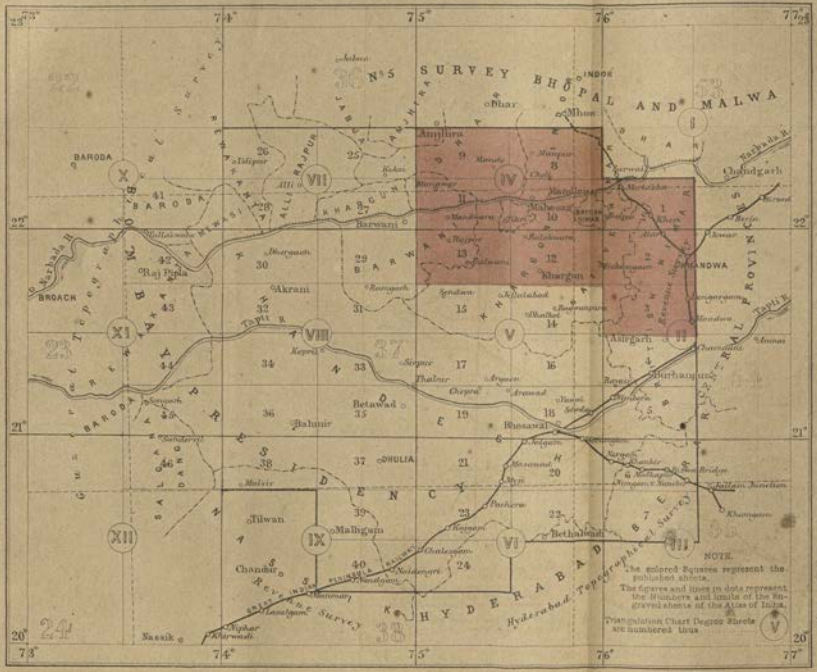
Published under the direction of Colonel W. L. Thuillier, C.S.I., F.R.S., Surveyor General of India.

Surveyor General's Office, Calcutta, March

No. 2 PARTY

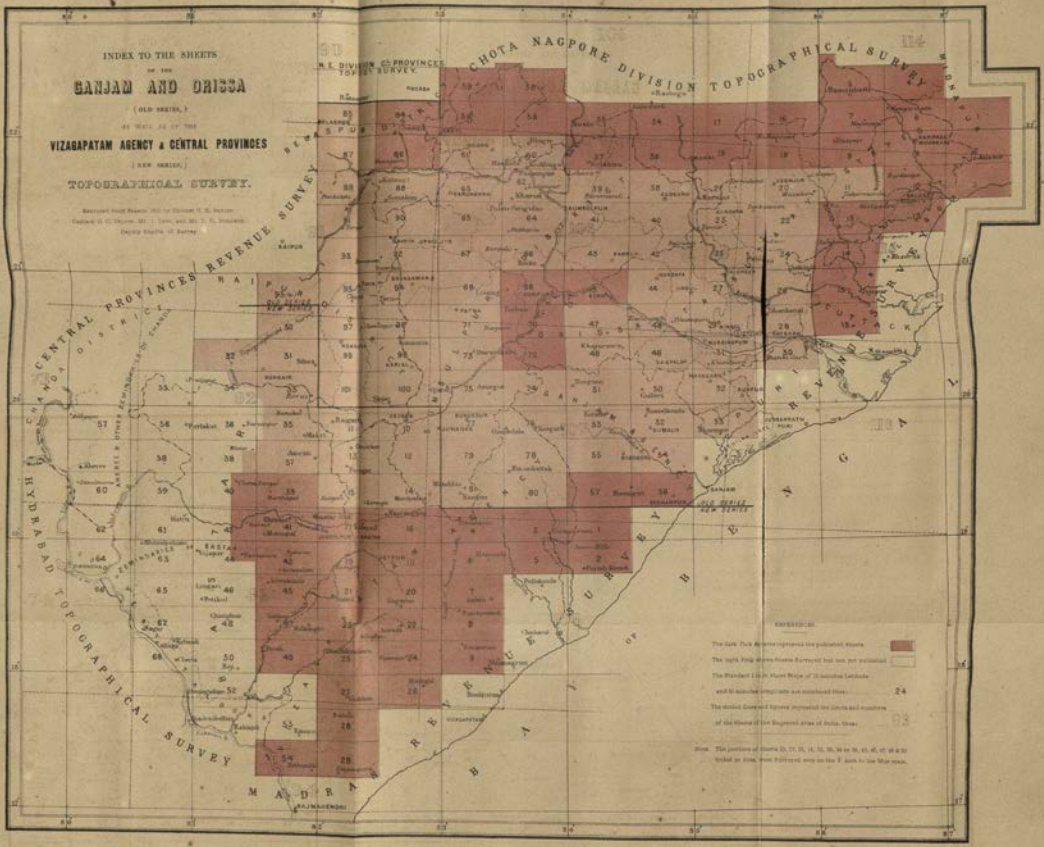
INDEX TO THE SHEETS OF THE KHANDESH & BOMBAY NATIVE STATES SURVEY.

On the Scale of 1 Inch = 1 Mile.



Published under the direction of Colonel H. L. Thuillier, C.S.I.—F.R.S. Surveyor General of India.
Surveyor General's Office, Calcutta, March 1870.

No. 3 PARTY



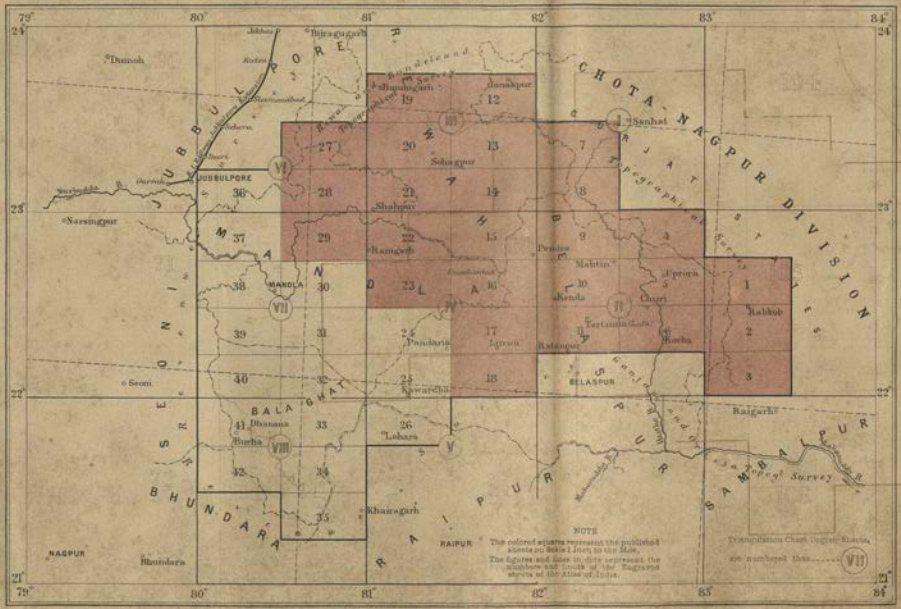
Published under the direction of Colonel H. L. Thuillier, C.S.I., F.R.S., Surveyor General of India.

Surveyor General's Office, Calcutta, March
1875.

No. 4 PARTY

INDEX TO THE SHEETS OF THE NORTH EAST DIVISION CENTRAL PROVINCES TOPOGRAPHICAL SURVEY.

On the Scale of 1 Inch = 1 Mile.



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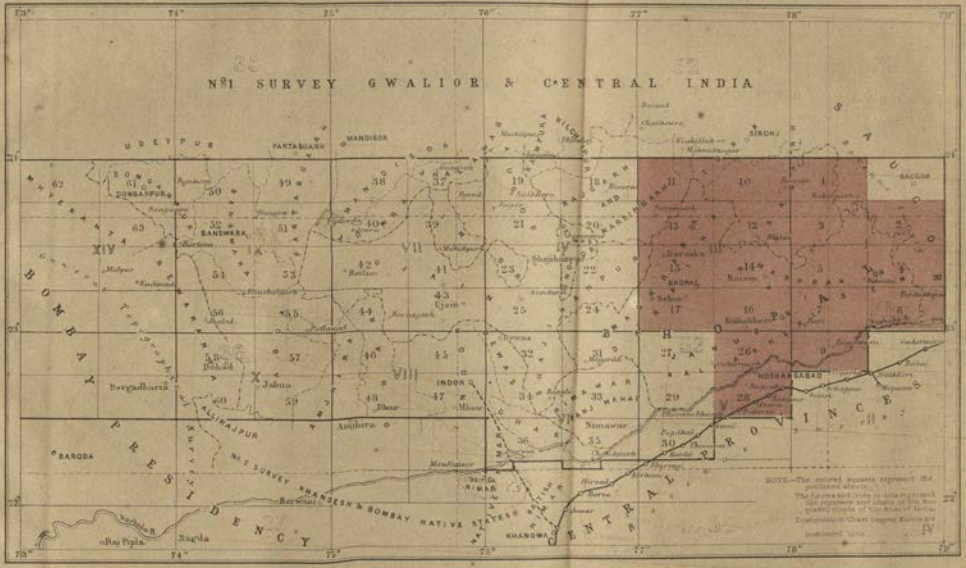
Surveyor General's Office, Calcutta, March 1875.

No. 5 PARTY

INDEX TO THE SHEETS OF THE BHOPAL & MALWA TOPOGRAPHICAL SURVEY.

On the Scale of 1 Inch = 1 Mile.



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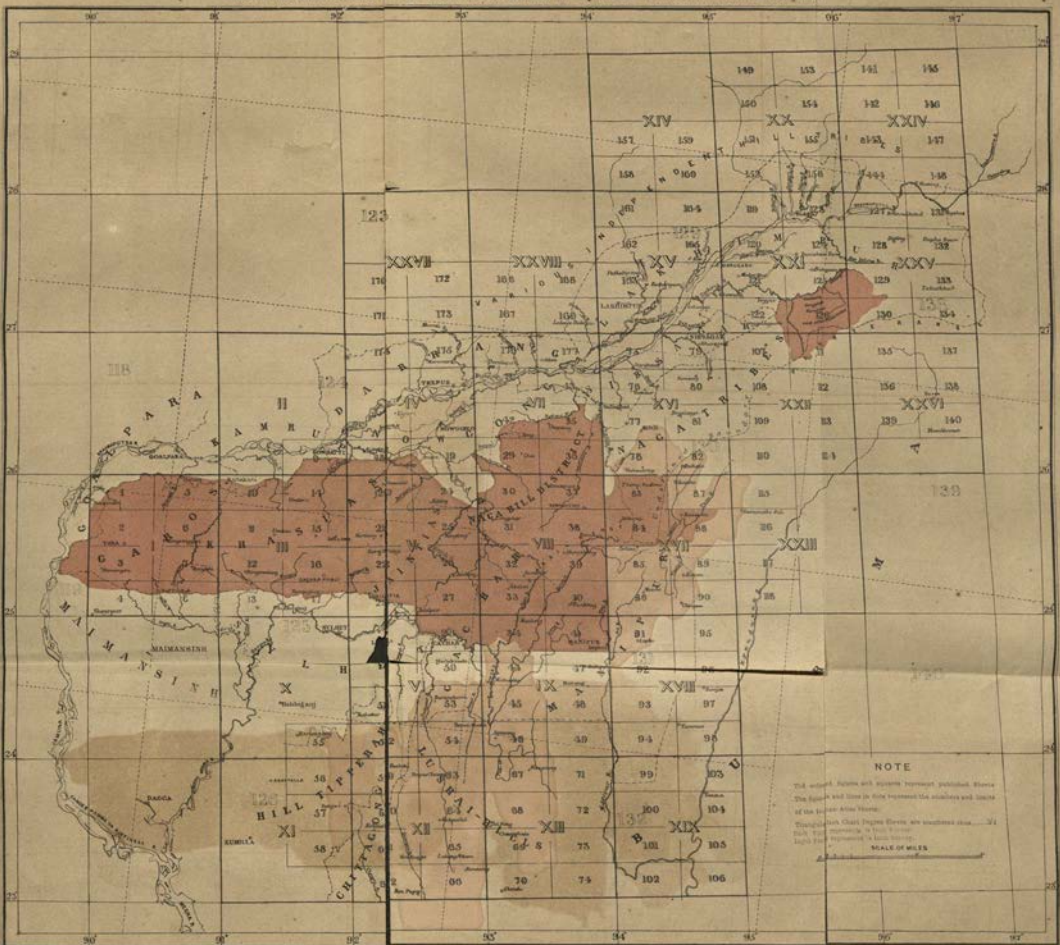
Surveyor General's Office, Calcutta, March 1870.

No. 6 PARTY

INDEX TO THE SHEETS OF THE GARO, KHASIA AND NAGA HILLS TOPOGRAPHICAL SURVEY.



Published under the direction of Colonel H.L. Thuillier, R.E., F.R.S. Surveyor General of India.

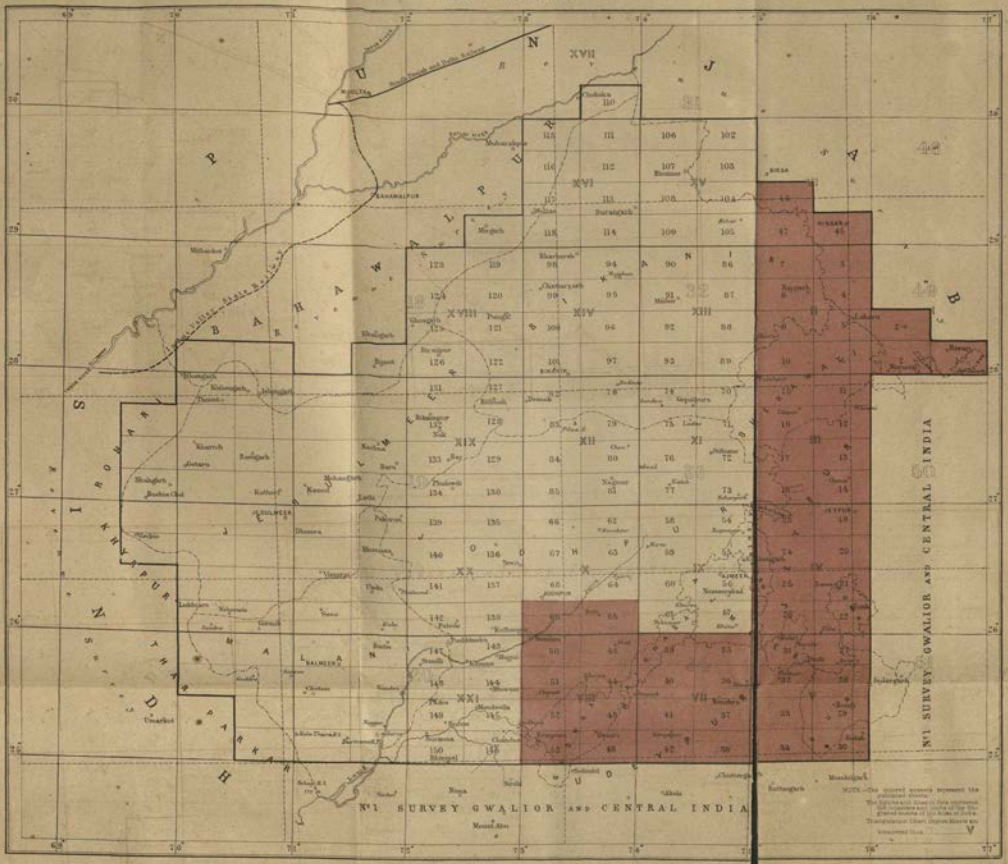
Surveyor General's Office Calcutta. March 1875.

Photolithographed under the superintendence of Capt. J. Waterhouse.

No. 7 PARTY

INDEX TO THE SHEETS OF THE RAJPUTANA TOPOGRAPHICAL SURVEY.

On the Scale of 1 Inch = 1 Mile.



Published under the direction of Colonel R.L. Thuillier, C.S.I. F.R.S., Surveyor General of India.

Surveyor General's Office, Calcutta, March

1873

APPENDIX.

REMARKS, PROFESSIONAL, GEOGRAPHICAL, AND STATISTICAL, &c., BY EXECUTIVE OFFICERS.

Extract from the Narrative Report of CAPTAIN CHARLES STRAHAN, R. E., *Deputy Superintendent in charge No. 1 Topographical Survey, Gwalior and Central India.*

Neemuch, Mundesore, &c.

The country that I was about to reconnoitre was divided into two portions by three very prominent scarps running nearly East and West, and facing Southwards. The northern slopes were very gradual, and as a rule very little broken, and, being covered with heavy jungle, would, I knew, present great difficulties to a triangulator. My starting point Rampura H. S. G. T. S. was well adapted for commencing such ground, as it was on the edge of the 1st or Southern scarp, and being on rising ground, had a good view over the jungle, and saw a considerable portion of the scarp to the North. Having reconnoitred over rather more than 200 square miles in plane-table, 158 in intricate jungly country, I observed over this bit, as at that time the weather was very clear, and I thought it better to observe at once under such favorable circumstances, rather than to run the risk of having thicker weather later on in the season, besides the chance of poles being blown down or removed, which in such ground would be a very serious inconvenience. On the 13th of December, hearing Major Martin, the Political Agent of Western Malwa, was to be at Rampura the next day, I rode into his camp and had an interview with Holkar's Subah of the District in his company, which I think facilitated our operations in his Subat. Major Martin has always been particularly willing to help us in every way, and without his efficient aid we should have had far more difficulty in a country so much cut up into small districts belonging to different Chiefs, as is the country between Neemuch and Jhalra Patan. After this I continued my reconnoissance Westwards as far as the meridian of 74° 30′ through the other three southern plane-tables (Nos. 160, 166, and 168) of my half of the triangulation; but then, finding that in consequence of the large extent of jungle I should not have time for a thorough inspection of the detail work if I attempted to complete the whole of the ground I had allotted myself, I omitted the North-Western plane-table No. 167 and returned through plane-tables 165, 159 and 157. I had the less scruple in doing this as plane-table 167 is in open, very easy ground, and including Mr. Scanlan's triangulation, I foresaw that there would be more than sufficient ground prepared for the season 1874-75. The three plane-tables (157, 159 and 165) were all more or less densely covered with jungle, so that with the exception of about 350 or 400 square miles, the whole of my triangulation (1,904 square miles) lay in difficult ground. Having completed my reconnoissance on the 3rd February 1874, I observed over it, following nearly the same route that I had taken whilst poling up, and observed at Bissangarh my last station on the 11th March. From there I marched *viâ* Bhynsrorgarh to Lieutenant Leach, whose work I inspected and then commenced the check lines through the other plane-tables.

Mr. Scanlan's triangulation.

After leaving Mr. Scanlan at Chichor H. S. in plane-table 161, I recommended him to work Westwards through plane-tables 164, 170, and 172, returning Eastwards through 171, 169, and 163, following the same general plan in observing so as to close near Rampura, that he might be at hand to take up any other work afterwards. This he did and met with no difficulty till he reached the Western portion of plane-table 170 and plane-table 172, all of which country was not only covered with forest, but was also inhabited by Bhils, who were very much averse to his even entering their country. He was at one time placed in a very awkward position near one of their Pals, as their villages are termed; but the Rajah of Pertabgarh in whose territory the Pal was situated, took up the case at once, and Mr. Scanlan afterwards became better friends with these wild tribes, and was enabled to finish his triangulation. I fear these Bhils may cause us serious annoyance hereafter, unless we are very strongly backed up by the Political authorities. When near the meridian of 74° 30′ our Western boundary of triangulation, I met Mr. Scanlan and was much pleased with the way he had reconnoitred and poled up the country. Soon after on the 21st January he commenced observing, and with the exception of a few days lost in consequence of hazy weather, he observed steadily until he finished at Rampura on the 18th March. His outturn is 2,176 square miles, about 400 square miles of which were in bad ground. This amount is I consider very good indeed for a first season's work, and I have much pleasure in reporting that the computations have shown that the character of the work is also excellent. His triangular error of 4″·8 and his linear error per mile of 1·43 inches for first class secondary stations, and of 6·0 inches per mile for intersected points with a 12″ theodolite clearly prove this. Mr. Scanlan bids fair to become a first class triangulator.

Large scale plan of Jhalra Patan city.

On completion of his triangulation, I instructed him to take up the large scale plan of Jhalra Patan city. During the previous season the cantonments of that place had been completed; but on hearing that these were all little more than "kutcha" buildings around the Raja's palace, and that the city was really the more important place, being walled and having a small fort commanding it, I determined to make one plan of the whole place, and, if possible, also to include the Fort of Gagrun (in Kotah) on the hills to the North of the cantonments. This fort is in reality the only position of importance in the whole situation, but I have been as yet unable to obtain leave from the Kotah Durbar to undertake it. I have written again on the subject, and hope to hear something definite on the subject soon.* The city and cantonments are now complete, but I am still keeping them in hand until I can ascertain for certain whether we can add Gagrun Fort. In consequence of the nature of the ground round Jhalra Patan, and of the distance between the city and Gagrun, nearly seven miles, I obtained leave to reduce the scale to 6″ to a mile. The cantonments are just about midway between these two places. Mr. Scanlan whilst working at this plan of the city added a few more heights in the neighbourhood.

Lieutenant Leach, R. E.
Plane tabling and supervising detail workers.

Lieutenant Leach commenced his plane table No. 150 at Nimthor H. (S. G. T. S.) on the 30th December. Nimthor, near the city of Bhanpura, is situated on the Eastern corner of the scarp. From Nimthor it runs due North. Above this scarp the country is very flat and covered more or less with jungle, necessitating traversing, giving him an area of about 100 square miles of this tedious style of work. In consequence of the grass and the thickness of the trees in the early part of the season, he confined himself at first almost entirely to the open country below, which was quite flat and highly cultivated. One section of this easy ground he gave to Mr. Knight as soon as Mr. Cornelius reported him fit for independent work. Lieutenant Leach could then closely observe how he got on with his work and was at hand in case he met with any difficulty. On the 16th and 17th of March I visited and inspected Lieutenant Leach's work in the neighbourhood of Hinglazgarh, a large old fort picturesquely situated in the jungle over a long narrow valley with precipitous sides. I found his work accurate and the ground well delineated. His outturn of 241·5 square miles by no means represents his whole season's work, for, as I have already mentioned, he had the entire supervision of the plane tablers whilst I was triangulating; he made several tours of inspection through them, besides having a considerable number of fresh boards to project and plot, so that it was not until my return in the middle of March that his time was uninterrupted. I have much pleasure in stating that he did all his work thoroughly and well, and that without his assistance to me in taking charge of the detail work and in sending me constant reports of progress, I could never have carried on my triangulation without entirely neglecting proper supervision of the rest of the party for three months.

Description of the country surveyed.

Of the country to the East of the Chambal I need not enter into a description, as Lieutenants Holdich and Leach have already described it in previous Reports. Our maps of this year speak for themselves as to the geographical features. I commenced my own triangulation from Rampura, as I have already mentioned, a G. T. Station 4 or 5 miles West of this river, situated on a precipitous abrupt scarp rising to a height of about 600 feet above the plains below. Rampura is a large town, on the site of an important Bhil city, I believe the residence of a Bhil Raja before the conquest of the country by the Rajpoots. Of the Bhil town there is scarcely a trace left, two small ruins on the lower slope of the hill being pointed out to me as the only remnants. It is now the residence of a Subah of Holkar's, having passed into his hands some years ago. A wall encloses the whole town, and indeed a good deal more, for at either end are large spaces now quite deserted, but showing signs of mud huts more or less all about them. There is still, however, a large inhabited portion with a good bazar, a great number of shops being kept by Borahs. I noticed a considerable manufacture of tulwars and knives of all sorts carried on, apparently entirely by these men. I visited the Subah there, who proved to be a most intelligent man, both writing and speaking English fluently. He was very proud of having been to England and of having spent a considerable time in London, where he seems to have been well received in society. He afforded us all the assistance he could in the matter of Vakils, &c., and I regret that he has been sent to another District, as there will be several plane tablers at work in Rampura this season.

This scarp runs nearly East and West, more strictly W.N.W. and E.S.E., to a point North of Neemuch, where the character of the hills changes. To the South the country is open and undulating, but not very fertile in consequence of the extreme stoniness of the higher parts, the vallies alone being fit for crops. Villages are pretty plentiful, and several well known towns, such as Sanjit, Mandesor, Sitamau and Nimbhera, and also the cantonment of Neemuch fall in this portion of the survey. Further West the ground entirely changed and became hilly, and in places covered with thick jungle. As Mr. Scanlan triangulated over all this country I have left the more detailed description to him; it will be found at the end of this Report. For about 20 miles West of Rampura, the scarp is very regular and unbroken with only footpaths at intervals up it, the better ones being accessible for camels with difficulty. For the

* Since writing the above, I have heard from the Political Agent, who states that arrangements have been made with the durbar for this survey.

next 12 miles the scarp is less marked and much broken, affording many easy roads to the northwards. There is one excellent unmetalled road through here from Neemuch *viâ* Dinkar to Singoli made by our Government before the Neemuch (Jawad) District was handed over to Scindia. After this the scarp again rises to its former height, though less steep, and there is far less jungle; but in a very short distance the character of the hills completely changes, as I will explain shortly. Immediately North of the scarp at Rampura, the country is one mass of jungle, much cut up by small valleys, all running Northwards, most of them having running streams of water, lasting all the hot weather, and flowing into the Ganjali river, which runs from West to East below the next scarp over Kuakhera and Jat, and which is at a distance of about 17 or 18 miles from and parallel to the Rampura scarp. This portion, the whole of plane table 158, is very sparsely inhabited, especially the Northern part, until you reach the strip of country near the Ganjali river, where villages are pretty frequent, and there is a good deal of cultivation where irrigation can be carried on from the river. As you get into plane table 160, to the West of this tract, the jungle becomes much less, and at Dinkar there is a considerable amount of open cultivated ground, the greater part of it being devoted to the cultivation of opium. Further West alternate tracts of stony jungle and of tolerably open country continue for the next 20 miles, until the same change referred to above takes place. Above this second scarp the same long gentle slope northwards is again found, but even more densely covered with forest and less cut up by valleys, and continues to the foot of the third scarp over Singoli. The drainage of this slope is all collected at the foot of the scarp and forms the Bamni River, which joins the Chambal at Bhynsrorgarh. The Singoli scarp is the highest of the three, the culminating points being just over 2,000 feet, the highest points of the southern scarp being between 1,900 and 1,950, whereas the intermediate scarp averages only 1,800. The bed of the Bamni River is about 1,200 feet, of the Gunjali 1,175, or nearly the same, and the open plain below Rampura is in the valleys about 1,350 feet above the sea level. The height of the bed of the Chambal River has not been as yet ascertained, but I propose to take it at a point south of Rampura, again when it enters the hills and also at Bhynsrorgarh, where it leaves our work. As I have already mentioned, these continuous and abrupt scarps terminate about the meridian of Neemuch, and the hills to the West all run North and South in more or less unbroken ridges, forming a number of small straight vallies, the widest of these being only about $\frac{3}{4}$ of a mile, and most of them less than $\frac{1}{4}$ of a mile mile in width. It is a most awkward and difficult country to traverse from East to West, there being so few passes; but from North to South almost all the valleys have more or less good roads. There is one capital track from Neemuch through Bijipur to Bassi, which passes right through these hills without any ascent or descent the whole way. To the South-West and North of this, the country is all open and cultivated with hills scattered about at intervals, but all showing the same tendency to run in ridges North and South. The famous old Rajput fort of Chittorgarh is situated on an isolated ridge to the West of these; it is about 4 miles long and at a distance of about 3 miles from them; and scarcely one in width, completely isolated, more or less precipitous on every side, and about 500 feet high. It is a most interesting place to explore, the Northern half of it being covered with old ruins full of historical interest. A detailed description of the whole fort and its history is given in Tod's *Rajastan*. It is no longer kept in repair, and consequently in many places the wall is falling down.

Difficulty of communication.

The whole country in which our work of this season lay was so divided up into small portions belonging to different Chiefs that it caused considerable trouble in procuring Vakils for every one; and as several of these small sub-divisions had scarcely any sowars to supply me with, I found great difficulty in keeping up my communications. Another cause of great delay in my postal arrangements was that men of one State objected to pass through another; the result was at times that my letters would stop at the boundary and not be forwarded for a day or two, until the men thought they had a sufficient bundle to make it worth their while to pass them on again. Do what I could, I never could make sure of this not happening, for I could never lay a continuous line of sowars or runners till quite the end of the season, when, on completion of my triangulation, I was enabled to make use of kalassies.

Notes by Mr. Charles A. R. Scanlan, *Assistant Surveyor.*

Topographical description.

The country triangulated by me lies between the meridians of 74° 30′ and 75° 30′, and between the parallels of 24° 0′ and 24° 30′, and, offered to me the initial elements derivable from 15 Great Trigonometrical stations whereon to base my work; and whilst this circumstance greatly added to enhance the value of it, the nature of the country was, with the exception of an area of 400 square miles, most favorable for Trigonometrical operations, and the only obstructions I met with were offered in the Southern portion of plane table 171, and in the whole of plane table 172, not only from the intricacies of the ground, but from the people of the country. The Great Trigonometrical stations of Rampura, Nankahuaro, and Malkhera, situated on the range described by Captain Strahan, just flanked my work, and rising to an average height of about 1,800 feet above sea-level, show the country to be depressed from 400 to 600 feet below their crests. Centrically placing himself in the considerable town of Mallargarrh, the traveller sees lying before him about 20 odd miles to the north this high range; while the

towns of Barra and Chota Sadri on his West, those of Damotar and Deolia on his South-West, Partabgarh, Mandasor, and Sitamau on his South, and Rampura and Chendwasa on his East (all large and important towns), may be said to be the limits of an open country dotted here and there with low hills, which only rise into prominence in the vicinity of Rewas and the sites known as Gopalpura, Jagapur and Balngara—Great Trigonometrical stations. Otherwise, the delineation may be described to be flat and well cultivated, with a good admixture of rolling and undulating ground traversed by numerous streams; all on the East of the cantonment of Neemuch and the city of Pertabgarh, affording tributaries to the River Chambaz; those immediately to the West of Partabgarh being the sources of the small rivers which ultimately flow into the Nerbudda; whilst those on the west of Neemuch join the Birach which washes the Western base of the hill on which stands the historical fort of Chittor. Lying directly to the West of the towns of Deolia and Damotar is the hilly and jungly ground I have already alluded to, every configuration being covered with dense teak and bamboo forest, which is about as thick a specimen of such as can be found anywhere else in India, and it is in this locality that the geological structure of the country suddenly changes; for whilst the hills already alluded to run East and West, those here, with a gap of about 15 miles between them and the former, lie North and South. The open country has numerous villages of good and respectable dimensions scattered over it, with about them the usual luxuriously plentiful growth of the poppy. There are also many large towns to be frequently met with, so that on the line of march one is always sure of getting some place of importance to encamp at. But I shall not stay to describe them, nor could I do so with satisfaction, traversing the country as I am with the speed of a triangulator: that duty will devolve on the detail surveyor hereafter, but I shall reserve to myself the saying of a few words on Partabgahrh and Deolia.

Historical origin of the town of Pertabgarh and Deolia.

These two towns, separated from each other by a distance of nine or ten miles, have been made famous in the history of Rajasthan from the circumstances of their having been built in about the year A. D. 1500 by Súrajmal, the founder of the present dynasty of Pertabgarh-Deola, and uncle to the Rana Sanga of Udepur. Were I to essay a history of this principality, I should be occupying more space than the limits of this Report permit; but on a future occasion I may be able to contribute a brief narrative of it to the literature of my Department, and so, for the present, I must content myself with a hasty sketch of it. Súrajmal was the uncle of the two brothers Pirthi Raj and Sanga, the latter not only being the heir apparent to, but having been pronounced the future swayer of, the Udepur sceptre by the sibyl of Nahra Magro, with Súrajmal as a portion holder. Immediately the oracle was pronounced by the priestess, Pirthi Raj endeavoured to falsify the omen by cutting down his brother Sanga, who fled, and of whose wanderings and loves many a romantic tale is told. Pirthi Raj assisted his father Raemal in quelling many disturbances and restoring order in disaffected portions of the State. Sanga still continued to live in disguise, whilst the wily Súrajmal was concocting many an intrigue. Eventually the latter was obliged to flee, and passing through the wilds of Kanthal had recalled to his mind the augury which gave birth to these feuds, as Tod in his annals translates it—"A wolf endeavouring in vain to carry off a kid defended by maternal affection;" and then continues: "This was interpreted as strong ground for a building. He halted, subdued the aboriginal tribes, and on this spot erected the town and stronghold of Deola, becoming lord of a thousand villages, which have descended to his offspring, who now enjoy them under British protection. Such was the origin of Pertabgarh-Deola." The town of Deola now presents a sorry appearance, and as one proceeds through it, the desolation of the place at once strikes him. Bounding the narrow streets on either hand stand up high walls composed of brick, off which the plaster has crumbled and fallen. You peer into house after house, and you find it silent and desolate; only here and there is a habitation with a tenant in it, and in street after street you look up in vain at lattices to catch the eye of a dark damsel peeping with curious awe at the European intruder; nor do you catch sight of the ubiquitous and fat and greasy bania, nor of the respectable Hindu with his white coat and variegated turban, nor yet of the slim figure of the impertinent and scowling Moslem with his licentious and bravado looks, for as you thread the ramifications of the town you meet only with the peasant class; and signs of active life, such as are incidental to a large native town, are only to be met with on entering the bazar, which also holds a solemn stillness, and you feel within you, and your eye emphatically tells you, that the shadows of ruin hover over this ancient site. You go on further until you reach the palace-yard, and yet the same stillness. You go through the haunts, the courts, and the halls of a princely domain, and beyond the sleepy guard in the quadrangle below, not a soul obstructs your way. You mount the turrets of the palace and have a bird's-eye view of the whole. Around you on the North-West and South you see naught but hill and jungle, but in the East the country opens out, and you see in the far distance corn-fields stretching miles away; but you cast your eye down, and below your feet lies the town of Deola, once so busy and full of life, now so fast running into decay. Desolation marks this place as her own, and as you visit the little balcony with its many colored glasses, and fine tracery worked out in its walls to enable the princesses to view the elephant fights below, and then as you visit the chief hall decorated from top to bottom and all ablaze with the glass and gold-work peculiar to this place, you cannot but help sighing over the fleeting nature of things human This is owing to the present chief having removed his court with all its belongings to Pertabgarh, which in itself is by no means a wealthy-looking town, especialy ewhen on has

been through the prosperous and large one of Mandasor, about fifteen miles East, and which promises yet to become larger when the State Railway to Rutlam from Neemuch will pass by it.

Pertabgarh jewellery.

The jewellery manufactured at Pertabgarh and Deola is very peculiar and deserves a passing notice, as at present it is immensely in vogue with our ladies. It consists of all sorts of shapes of green glass in which are set grotesque figures of animals, gods, men and trees, representing hunting scenes; and from the figure of the lion appearing so often among them, we must at once conclude that here in bye-gone times this beast was common and used to be hunted. At present we do come across a stray one now and again in this vicinity, and as we approach closer to the Alpine Aravalli the chances of meeting them not unfrequently occur. These jewels are used for bracelets, earrings, and brooches, and are generally valued at from Rs. 3 to 7 each, but the prices vary according to the size of and working on the stone. The men whose handiwork these little gems are will not disclose the secret of their trade to any one, and so jealous are they of it that they will not permit their daughters to enter the rooms wherein they work, lest on marrying they should divulge it to their husbands. Some of these works of art I have seen executed on a glass of a rich ruby color, and the effect of the gold in antique styles was very pleasing. This is especially the case where several delineations of the chase, the amours of the gods, and other subjects are to be found on the walls of the reception room of the Deola palace, where the plates are about a foot in length and half a foot in breadth.

The caves of Dhamnar.

To the careful inquirer and watchful observer there are many most interesting morceaux which offer themselves for his speculation, and he has only to ingratiate himself in the favor of the lords of the country and he will be able to glean much from them. There is a great deal, too, that will interest the archæologist, and for him mines of wealth lie hidden and unexplored in Rajasthan; and when our Archæological survey enter these fields they will stumble on many a record of antiquity which will serve to throw additional light on the ancient history of the Hindu family which was cradled and reared here. I shall now proceed to describe the caves of Dhamner as I found them, without venturing my personal opinion as to their origin, being thoroughly ignorant of such matters. The hill on which these troglodyte dwellings are situated is the site of a station of one of the Great Trigonometrical Survey, and also of one of our 1st class secondary points, the latitude and longitude of the former being 24° 11′ 37″ and 75° 32′ 27,″ and near which only about 30 feet off to South-West lies the principal temple which is very nearly the centrical situation of the two hills wherein the excavations are. The elevation of the station is 1,591 feet above sea level, and about 200 feet above the surrounding country. Tod describes the rock of the hill to be a cellular iron clay so indurated and compact as to take a polish. I will quote him a little further: "There are traces of a city, external as well as internal, but whether they were contemporaneous we cannot conjecture. If we judge from the remains of a wall, about 9 feet thick, of cyclopean formation, being composed of large oblong masses without cement, we might incline to that opinion, and suppose that the caves were for the monastic inhabitants, did they not afford proof to the contrary in their extent and appropriation." Our author has so fully and perfectly described these curious dwellings, that I shall not dare to offer on the opinions he advances a single one of my own. I shall leave it to General Cunningham and his colleagues to discover whether Tod is right or not; but I lean to the opinion, that whilst they will perhaps be able to add much to what he puts forth, they will certainly not be able to take aught from it. This able and piquant historian, writing almost with the grace, fluency, and retentive memory of a Macaulay, visited these interesting ruins in 1821, whilst I had the fortune to do so 53 years later. I find some of the idols and a few objects he speaks of missing, notably the only few isolated and undecipherable letters he came across; and with the exception of one slab which had the remains of one or two letters on it, I found nothing after a very careful examination to give me even an idea of a once existing inscription on any spot on the surfaces of the multitudinous caves. I am of opinion that something could be gleaned regarding this curious locality if extensive excavations were made, and I am sure that the patient seeker would meet with a rich reward. I do not think much opposition would be offered, and if any were, it could be overcome by the good offices of the Political Agent. There is here a garrulous old fakir who is the only human tenant of the place, and has as his companions many hyænas and a tiger or two. He told me as the place was still the site of an annual religious meeting, it was of course still sacred; and as he was the sole authority there, he would not object to a search being made, provided that if any wealth turned up, he would have half of it. The tops of the hills are flat, and in an excavation cut into the pure and solid rock, 30 feet deep, 100 feet long, and 66 feet broad, stands the principal temple, whose summit rises flush with the surface of the hill. I descended by a flight of steps in its north-west angle: this flight embraces the Northern face of the hollow, and so leads to the base. The temple faces East, and in each of the four angles of the excavation stands a temple, whilst immediately to the back or the west of our principal shrine is another minor one; and also one other at its Northern and another at its Southern face. All these hewn out of the massive rock are of Jain architecture. They are not built, nor does there exist a single seam or disjointed stone to show that they have been so formed. Entering the portal of the chief temple, a passage leads to the sanctum sanctorum, and we see the god Mahadeo, formed of a small block of cylindrical stone, the emblem of procreation. Looking down on him from the face of the wall sits the four-armed deity

Chattarbhuj. In his right hand he holds a baton or gattka; in his left hand a chakar or circle; in the lower left a conch or sank; whilst his other right hand is empty. Entwining their coils over the shins of his legs and appearing from behind are two serpents, nags or cobras; he is surrounded by other images of various forms, and stands about three and half feet high and has a sun refulgent at the back of his head. Four pillars, two on either hand, form the central supports of this massive and colossal structure. On either side are two wings, in each of which is a massive window 5 feet deep, 5 feet broad, and about 6½ feet high; little port holes, 14 in number and of an octagonal form, let in the light through the rock curtain of each window. The middle passage is 28 feet long and 6 feet broad; the two wings being 18 feet long and 5 feet broad. In the eastern extremities of each of these wings is a niche; one is simple, the other has in more recent times been made into a recess, and has engraved on the stones used to form it the god of learning, Ganesh or Ganpatti, showing this addition to be of the Shivite period. In fact, there can be no doubt about it that originally this place was dedicated to the worship of Buddha, and in more recent times changed hands with the votaries of Shiva. The roof of the temple is cut into large leaves and petals, and here and there peeping out among them are small images. The entrance to the sanctum is decorated with an elaborate scroll work of flowers and images, showing men playing the drum, and women in dancing positions and amorous attitudes. In the sanctum itself occupying the centre of the floor is Mahadeo, and as before described, Chattarbuj or Vishnu, moulded apparently out of a finer description of rock than that which is characteristic of the rock of the hill. The roof of this chamber is again cut out in form of leaves, petals and flowers, meant no doubt for the lotus. The south-west temple is empty, as also are those occupying the north-west, the south-east, and north-east corners. When Tod visited them, they all had some gods set up in them. Near the shrine in the north-east corner is a well excavated to catch the rain. The temple to the North contains nine avatars or deities, whilst in the one to the West, Narriana reclines on a serpent monster, with a baton in his upper right hand, and in the lower one apparently a flower with the goddess Lakshmi composedly sitting at his feet. A tiara or crown is suspended over his body; and his left hand being broken, it is impossible to decipher what it grasped. His body is enveloped in the folds of a hydra, which is supported on the heads of human forms, male and female, playing on the tabor, the flute, cymbals, and the lyre. There are some other figures in an excited and fighting attitude at the feet of, and on the same level as, the god. All the effigies in the relievi are naked. On the southern face of the scarp of the excavation containing the temple is cut into the rock a dwelling for the resident priest.

Leading to the East of the temple, we stand under a porch still formed out of the pure rock about 20 feet broad, long and high, surmounted by a solid body of rock of about the same cubical measurements. This has also two niches on its southern and northern faces containing images of Bhainro and Devi, respectively. Passing out of this portal we immediately issue into an extraordinary passage in its entire length cut out of the virgin rock. Its total length is 252 feet; it is 12 feet broad and 30 feet deep. At the 146th foot, a bridge, part and portion of the faces of the passage, surmounts it; and here the outlet begins to widen, for we find the bridge to be 18 feet long. At this point this gallery deflects at an angle of about 30 degrees from the east towards the south; and at a distance of 60 feet we stand under another bridge and in another portal, passing out of which, 46 feet more bring us to the end of this strange excavation, and to the beginning of a slope which leads over the last-mentioned bridge to the site of the temple which I have just written off. On the south face or scarp of the hill on which this temple is situated lie the caves, which are still in a semi-state of preservation, and which appear to have been the principal ones, for these excavations are to be found on every aspect of the scarps of the two hills, but all the others, from the action of the weather and other causes, have crumbled away, and huge masses of rock at the bases of the hills show where lie the fragments of these once inhabited dwellings. In one of the apartments of these curious temples we come across gigantic figures, some sitting, some reclining, and some standing, varying in heights. The recumbent one, supposed to be the representation of a dying Jain pontiff, is 14 feet in length. Throughout we notice supporting the roofs, some of which are vaulted and ribbed, emblematical figures, whose base is square, and standing on the latter the shaft of a pillar, which is surmounted by a globe from which proceeds a continuation of the shaft till it reaches the roof, and all these, some huge and some moderate in size, are, like the rest of every other feature on this hill, chiselled out of the rock. Tod styles these supports dhagops, which are all named after the sacred mounts of the Jains. Some of them now stand looking up to the vault of heaven, in dire contradiction of the creed they were meant to illustrate, for their roofs in all probability crumbled away centuries ago. The most extensive excavation locally known as Raja Bhim's Bazar contains a central structure, supported by one of the above described dhagops, and is surrounded by several little rooms, in which we find sitting cross-legged the figure of Chandra Prabhu, and the hole made by the thief Koria Chor who robbed the Pandevas of their kingdom, is still pointed out in the vault of the treasury by the anchorite cicerone. The tree described by Tod is in existence and protrudes out of the rock; it shoots upwards to a height of about 15 feet, then twists itself out of a portal to a length of about 20 feet, and then normally sends its branches forth vertically, and is a flourishing and sturdy old fellow. The entrances to the caves all bear signs of once having had attached to them wooden doors and posts. There are many underground and dark passages. I came across one, but as it was inhabited by a tiger, my spirit of curiosity was not sufficiently strong to induce me to enter it. I am of opinion that these

passages lead into large and spacious subterranean vaults, all connected with one another, and it would, I think, be worth while to explore them. I noticed the remains of an old masjid or Mahomedan place of worship on the hill. But it is only of very recent date, and was most probably erected by some Mussalman in gubernatorial authority under the fanatical and iconoclastic Aurangzeb; and no doubt, no sooner the power of the Holkars was fully re-established, the masjid fell into disuse, and here were heard no more the azans of the Moslem. Such other troglodyte dwellings are to be found elsewhere in this part of the country; but not having visited them, I cannot say whether they are of the same period architecturally, or formed by men bowing to the same gods as did the ancient inhabitants of Dhamnar. Passing over the traffic, products, roads of communication and such other details which the plane tabler will have more time to enquire into and describe with greater accuracy, I shall close this sketch by narrating what might have been a serious *contretemps* between me and the Bhils of Gangia-ka-Pal.

The Bhils of Gangia-ka-Pal.

It was with no little difficulty that I managed to get into this stronghold, and since the site of the station marked as Gangia-ka-Pal is a *sine qua non* in forming the net work of my triangulation, the necessity was paramount that I should leave no stone unturned to get into this fastness, and to ensure the friendly co-operation of these men, for without their aid it would have been impossible for my heliotropers to have occupied the hill, situated as the spot is in a howling wilderness: and I am certain without such co-operation they would not have permitted my men to remain there. Long ere I came into the vicinity of this locality, its notoriety had reached my ears, and I had over and over again been cautioned to be particularly careful when visiting it; but relying on the prestige of our Government, I entertained the fond and, perhaps, plausible idea that no sooner should I approach this den and amicably explain my purposes, then I should be received and admitted with the same frankness and cordiality with which we are generally greeted all over the country. Having, as I thought, no further need of his help, I had dismissed my Pertabgarh vakil (or agent from that Court) who was replaced by one from Udepur. But as I afterwards learnt this place was in the Pertabgarh principality, I immediately despatched a messenger recalling him, *ad interim* reconnoitering to the West and North-West of this *locale*. On my return to my camp, from which I had been absent two days, I found the vakil had not arrived, and as time was precious, I forthwith ordered a march into the Pal, adopting the precaution of enlisting the services of the Bhumia Thakur of Dhariawad, and as he so readily had proferred them, I accepted them. But it was rather a *faux pas* my taking him. A *Pal* in the parlance of the Bhils means a collection of habitations scattered over an area of perhaps three and four square miles, or more, all bearing the same name, which is that of the headman, similarly as the tents of a body of Banjaras are collectively known as the *Tanda* of such and such a naik. The Thakur had undertaken to precede me, and so I thought all was square; but no sooner did I break into sight on my elephant, than the angry and vituperative shrieks of women assailed my ears, together with the alternating low murmurs and up-raised voices of an angry crowd of men, who, armed with guns, swords, bows and arrows, in the space of a few minutes, confronted me. Expostulation was in vain; to get a hearing impossible. They shrieked and yelled, swore and abused, and imperatively gave us our walking ticket, which we were obliged to accept with all the grace at our command. I am convinced that the slightest indication on our part to make our conduct one of *sauve qui peut* would have formed their minds, and they would have made a closer acquaintance with us than they did. We had not gone far on our return journey when they fired volley after volley to proclaim our defeat, but it was not till afterwards that I learnt they fired in our direction and sent after us such strong arguments as leaden bullets. But as we were well out of the reach of their guns, we were in blissful ignorance of the compliment which had been paid us. I marched into Chitoria quite crestfallen, and my chagrin was great when I thought of the many variations the people would play on the unfortunate chord which I had struck. At about 8 o'clock at night, whilst I was chewing the cud of resentment, my Pertabgarh vakil arrived, and next morning he started for the Pal, accompanied by a trustworthy khalasi of mine, to bring me in an ungarbled statement of what might occur. They were received in precisely the same manner as I was, if anything warmer, as, anticipating my early return, the men of the Pal showed a front of all their braves. At seeing the vakil and his accompaniment they clapped their hands to their mouths and set up their peculiar howl with cries of mar, mar, thirre, thirre, fire, fire, scatter, scatter. For an hour the sword of Damocles hung over the heads of this plucky band of five men; until at last the youngest brother of the Chief Rama recognised an old Pertabgarh sepoy; he gave a magical whistle; every sword was returned to its scabbards; bows were unstrung; and signs of a friendly greeting began to appear. It was then explained that the whole front and root of their conduct arose from the Thakur accompanying me, and as in these parts every man's hand is against his neighbour, so they concluded that the Thakur had brought a Feringi back with a force to avenge the wrong which this clan had inflicted on him. The vakil returned late that night with two brothers of the Chiefs, and next moring I marched again for the Pal. But so suspicious were these men of my intentions, that though they sent the two brothers to me, yet they had an idea my motives were not amicable. I had scarcely gone beyond the precincts of my encamping ground when I was joined by three or four men, and by the time I got into the Pal I had quite a little host of these free-booters about me—clearly showing that they had silently taken up a position near my camp the preceding night immediately to release their Chiefs or avenge them if I attempted aught with them. When in their fastness I was at once

struck with the absence of the women and children, when I discovered them in their black skirts with the aid of my binoculars hidden in the surrounding forest, and when I got close up to the council chamber, from on top of my elephant, I saw its yard crowded with men ready for an affray. But I had not been ten minutes with them ere we were very friendly, and a perfect understanding had been established between us. It is no exaggeration to say we must be very guarded in our dealings with these wild tribes. There are Pals ahead which are spoken of as being more unruly than the one in which my experience has been gained. With a firm will and a kind and courteous deportment we shall effect our purposes; but these men are very suspicious, and on no account must we ever permit their suspicions to get the better of them; for, if they once distrust a man, nothing will induce them again to approach him or do aught for him. Their character has been fully explained to me by the thakurs or lords of the soil; they have given me illustrations in many anecdotes, and it will be wise for us to profit by the admonitions we may thus opportunely get. I have already taken up two much space, and so am precluded from writing on other interesting topics, which I hope I shall be permitted to do in my report for the ensuing season.

Extract from the Narrative Report of F. B. GIRDLESTONE, Esq., *Deputy Superintendent in charge of No. 2 Topographical Survey, Khandesh and Bombay Native States.*

On the Perbudda.

The area partially triangulated and finally mapped during last field season embraces portions of Holkar's territory, Dhar, Burwani, Scindia. The Dewas Rajah's and the several Bhumias or Bhil independent Chiefs in Nimar and Holkar's and Scindia's territory, Dhar and the British Pargana of Manpur in Malwa.

The territory styled "Bhoomiahs" belongs to three Bhil Chiefs who reside at Nimkhera, Jamnia, and Rajgarh. They own, respectively, the parganas called Hindola, Jamnia (also known as the 47 paras), and Rajgarh. These men are entirely independent of all the other States, but are under British protection, and their estates are under the guidance and supervision of the Officiating Bhil Agents at Manpur and Dhar.

These Bhumiah estates are situated on the slopes of the Vyndhias in the midst of very wild and rugged country. They are entirely populated by Bhils. The sunnuds conferring their titles to those estates were given by Sir John Malcolm, many years ago, on the understanding, I believe, that the main passes from Malwa to Nimar were to be protected by the Bhumias, or in compensation, perhaps, for the plunder they used to take from travellers going up and down the same. These Bhumias held great authority and influence over the Bhils.

The following table shows the parganas of the different Native States which have been wholly and partially surveyed by No. 2 Party up to date:—

Completed Holkar's.	*Incomplete Holkar's.*
Amláta.	Barúr.
Bávi.	Chikalda.
Bárwai.*	Cheinpúr.
Bagdhárá.*	Jellalabád.
Balakwárá.	Khargún.
Bamangáon.	Nángalwári.
Bhamnála.	Sángur.
Bhikangáon.	Sarisgar.
Dhargáon.	Sendwá.
Didlá.	
Hasora or Indora.*	
Haselpúr.*	
Jám or Indore.	
Kásráod.	
Koselgarh.	
Kurgáon.	
Lawáni.	
Máhesár.	
Mundi.*	
Mardána.	
Pasalia or Indore.*	
Sanáwad.*	
Un.	

Completed Dewas Rajah's.
Bagoda.*

Completed Dhar.	*Incomplete Dhar.*
Bálkhar.	Kukse.
Dhár.	
Dharampúri.	
Gújri.	
Mándo.	
Nálcha.*	
Tikri or Sultanabád.	

Completed Scindia's.	*Incomplete Scindia's.*
Amjhara.*	Balwári.
Bákaner.	
Dikthán.*	
Manáwar.	
Piplia.*	

Completed Burwani.	*Incomplete Burwani.*
Anjer.	Burwáni.
	Páti.
	Rájpúr.

Completed Bhoomia.
Hindola* or Nimanpúr.
Jámnia.

Completed British.
Beriá.
Mánpúr.

Remarks on the country finally mapped this season.

Most of the tract mapped this last season has already been described in my two previous annual reports. The chief feature in the season's work is the great range of the Vyndhias, which extends like a great wall from East to West through standard sheets Nos. 8 and 9, and whose Southern edge forms the boundary between Málwá and

* Signifies that a portion of this pergunnah has still to be surveyed by No. 5 Topographical Party.

Nimár. This range where it enters the eastern limit of standard sheet 10, stands 2,059 feet above sea level or 1,737 feet above Nimár, and 540 feet above the Málwá plateau; between this point and Lalgárh which is on the western edge of sheet No. 9, the range falls considerably, as there its height is 1,796 feet above sea level or 1,150 feet above the plains of Nimár, and little, if anything, above the average height of the Málwá plateau. In this distance of 60 miles there are several high peaks standing on, but well above, the main range; thus there are the well known hills of Dhajárá, a sharp peak in plane table 10 which = 2,676 feet, Singarcháori in plane table 11 = 2,885 feet, Mándogarh in plane table 12 = 2,205 feet, Mograbá in plane table 12 = 2,456 feet, and Arvaili in plane table 11 which = 2,162 feet.

The Vyndhia range falls to the level of the Málwá plateau by long and easy slopes, but to the plains of Nimár the descent is most precipitous. There is a scarp of over 300 feet in height right along the southern face, except in the valleys where the Káram and Mán rivers burst their way through towards the Nerbuddá. All traffic by carts and laden animals is impracticable except by the routes along these rivers. The ground near the fall of the Málwá plateau to the plains of Nimár is everywhere very wild and rugged, and the deep gorges through which the rivers and streams generally run make it a difficult matter to travel about the country. On the Málwá plateau are many isolated hills averaging 300 to 400 feet in height. Below the range in Nimár the ground slopes to the Nerbuddá by a series of undulating plateaus covered with high grass and jungle.

Rivers.

The largest rivers met with were the Chorár in plane table 10, the Káram, Ajnár, and Mándáodi in plane table 11, the Khúj, Mán, and Deláori in plane table 12, and the Deb and Borár in plane table 16. All these rivers flow into the Nerbuddá and take their rise from the Málwá plateau. The great watershed of Málwá is a high ridge, which breaks off from the main range of the Vyndhias, 2 miles to West of Jám in plane table 10 and runs thence in a North by West direction 3 miles east of Mánpúr, and from thence in a northerly direction to a few miles west of Indore. From a flat plateau called Jánápáo on this chain, five large rivers take their origin, the Chámbál and Nákheri flowing to the North into the Ganges, and the Chorar, Kárám, and Gamni south into the Nerbuddá. At this spot a large temple has been built, and it is a great place of pilgrimage from all parts of India. Jánápáo is about 6 miles south-west of Mhow and 5½ miles from Mánpúr on the Agra and Bombay road. The temple on the hill is 2,798 feet above sea level. The Konti and the Bedá rivers drain all the tract surveyed in plane tables 2 and 3. None of the above rivers are navigable, though there is always a considerable amount of water in them even in the hot season.

Nerbuddá river.

The heights of two stations in the bed of the Nerbuddá river have been very carefully determined. The one is the base of the masonry telegraph tripod in the centre of the river ¾ miles East of Mortakka in plane table 1, which is 509 feet above mean sea level. The other is close to East of Kheri village in plane table 17 in $\frac{\text{latitude } 22^\circ\ 4'\ 50''}{\text{longitude } 76\ \ 0\ \ 28}$, which is 362 feet above mean sea level. The distance between these two marks taken along the bed of the river = 73·5 miles, which gives 2 feet as the average fall per mile.

Ferries.

In addition to the ferries over the Nerbuddá named in paragraph 44 of my last Narrative Report, the following have been noted in this season's work, *viz.*, a bridge of boats between Mortakka and Kheri in plane table 1;—

Ferry	Kotár	and	Elsár	in plane table 1.
„	Mota Alli	„	Murála	„
„	Toksar	„	Súnala	„
„	Datwárá	„	Wurdáná	„ 17.
„	Chota Barda	„	Semaldhá	„
„	Nalwai	„	Ratwa	„
„	Aoti	„	Ekhalwára	„
„	Piplúd	„	Gangli	„

Tanks.

There are 13 large tanks in plane table 12, *viz.*, one at Salkanpúr, one at Pandrika, one at Miapúrá, two at Nálchá, two between Nálchá and Mándo, and eleven on the Mándo plateau, of which those called Datthobán and Ságar are large sheets of water. There are also large tanks at Choli in plane table 11, Kánjer and Sundreil in plane table 2, Jetwai and Jám in plane table 10, and at Singáná, Anjer, Wáil, and Ajendi in plane table 17.

Rivers of Mándo.

Mándo, the capital of ancient Malwa, in $\frac{\text{latitude } 22^\circ\ 20'\ 50''}{\text{longitude } 75\ \ 26\ \ 25}$ and 1,948 feet above sea level, fell within the season's work. To those who do not mind a 30-mile ride from Mhow over bad roads but through well-wooded and cultivated country, the ruins of this large and picturesquely situated city will ever repay the toil and trouble taken to reach them.

The city, whose walls as measured from the field maps are just 30 miles in circumference, stands on a plateau about 8 square miles in extent. This plateau is really a peninsula of the table land of Málwá, from which it is separated by a valley some 200 feet in depth and 300 yards in breadth. On all other sides the plateau is surrounded by precipitous hills. To the

South the Vyndhias completely bar all access, for they there drop to the plains of Nimár by a precipitous wall of 1,254 feet. Indeed, the only access to the outer world from this city was by the five gates called the Delhi gate, the Tarapur gate, the Bagwániá gate, the Jehangirgarh gate, and the Rámpúr gate. Paved roads have at incredible labor and expense been made from the gateways to the plains of Nimar below. Portions of these are still in good order; abundance of water, rich soil, and salubrity of air, together with the natural strength of the position, are probably what caused Mándo to attain its state of great prosperity. The enormous mass of ruins of palaces, tanks and temples, and of towns and villages all round prove that the city must have attained such. For three and half centuries indeed it was the residence of kings and their vast armies, and it was only when these were destroyed and scattered by constant wars that the tradesmen left the place and sought other marts for their wares. The remainder of the townsmen and camp followers then formed themselves into predatory bands, and became notorious afterwards as "Pindharees" and gradually the city became deserted. Mándo, once the mart of merchandise, the place of skilful artizans and the abode of the wealthy, learned and religious, and the stronghold of potentates, rapidly became the refuge of robbers and wild beasts.

Inhabited now by a few wretched Bheels, the ruins are rapidly going to decay. The roots of the pipul trees which are everywhere growing amongst them force the stones asunder and rapidly level to the earth these splendid architectural remains; in every direction are seen rank vegetation and tottering ruins, and amongst these, where stately courts were once held, and audiences given to ambassadors from all parts of the world, wild animals now roam and make their homes.

The following buildings are well worthy of a lengthened visit and inspection:—

1*st*, the Jumah Musjed, a large rectangular shaped building with pointed gothic arches surmounted by a dome; 2*nd*, the Jaház Mahal or water palace, which to my thinking is most exquisite both in design and situation. It is surrounded by large lakes and noble trees. From its upper terraces there is a magnificent view over the whole plateau. This lovely palace is almost buried in rank jungle, and its lakes are covered with wild fowl. Time, however, has dealt gently with the masonry, and the terraces and walls are still in a fair state of preservation, though on all sides their appearance from the grown up jungle and weedy morrasses and perfect silence is most sad and desolate; 3*rd*, the Hindola Mahal; 4*th*, the Taweli Mahal; 5*th*, the Champá Bouri; 6*th*, the palace of the Sultan Báz Báhádúr and pavilion of Rupmati his Queen, from the terraces of which the views are most lovely, and superior in extent and beauty to any other at Mándo; 7*th*, the marble mousoleum of the Sultan Hosein Shah Goree; 8*th*, the Delhi gate. This was the chief gateway from Mándo towards the north, and of considerable height and depth. The top has nearly all fallen in, but it is still worthy of a visit on account of its beauty of construction. From this gateway the road runs along what was the main street of the town, along which there are many large ruins visible.

Towns.

Mánpúr, in latitude 22° 25′ 52″, longitude 75° 39′ 46″, height above sea level 1,888, population 1,257, was the most important town met with this season. It lies on the high road from Agra to Bombay, 12 miles from Mhow, and 3½ miles from the south edge of the Málwá plateau. It is the principal town of the British pargana of this name, which contains 37 villages in all. The Officiating Bhil Agent who has charge of Mánpúr, as well as the supervision of the various Bhumia territories, has his residence here. There is a court house, school, dispensary, and police station in the town, which has every appearance also of being thriving and flourishing.

Bárwái.

Bárwái, in latitude 22° 15′ 19″, longitude 76° 4′ 57″, height above sea level 629, population 3,796, souls is the capital town of Holkar's pargana of this name in Nimar. There is an extensive trade between this place and Mandlesar, and so soon as the State Railway from Khundwá to Bárwái is opened, as expected in two years' time, this traffic will no doubt considerably increase, especially if a metalled road is made, as His Highness Holkar now proposes, between Bárwái and Mandlesar, Máhesár, and Gujri. Such a road is greatly wanted in order to carry off the produce of the very rich tract of country lying along the Nerbuddá. Cotton, wheat, and opium thrive greatly there, and large quantities would leave the province were this route only opened out.

Mota Mortakka.

Mota Mortakka, in latitude 22° 13′ 17,″ longitude 76° 5′ 22,″ height above the sea level 566, with a population of 244, souls, is a large and thriving place on the banks of the Nerbuddá. This is the chief town in the pargana of the name forming part of British Nimàr. Being at present the terminus of Holkar's State Railway and the site where the bridge for the same is now being built to cross the Nerbuddá, and there being several thousand temporary laborers employed thereat, it has a thriving and busy appearance. There is a school, court house, police station and dispensary here, and the tehsildar of the pergunnah also resides here.

Naleha.

Naleha, in latitude 22° 25′ 18,″ longitude 75° 27′ 15,″ height above sea level 1,905, with a population of 1,188, souls is a large village belonging to Dhar, beautifully situated in well-wooded country 24 miles West-South-West of Mhow. The whole of the surrounding neighbourhood is perfectly

strewn with architectural remains. There is also good shooting, both big and small, round this place.

The following were the only other places of importance met with :—

Town.	State.	Latitude.	Longitude.	Height above sea, &c.	Population.
		° ′ ″	° ′ ″	feet.	souls.
Bhikangáon ...	Holkar ...	21 52 7	76 0 26	940	183
Cheinpúr ...	Ditto ...	21 42 46	76 2 15	1,030	152
Choli ...	Ditto ...	22 15 0	75 42 45	721	630
Haselpúr ...	Ditto ...	22 29 15	75 40 34	1,900	1,000
Jám ...	Ditto ...	22 21 45	75 47 5	2,180	.....
Lawáni ...	Ditto ...	22 18 47	75 21 42	889	149
Singána ...	Half Dhár ...	22 11 26	75 0 47	569	1,045
Bákaner ...	Scindia ...	22 11 0	75 12 8	485	496
Khal ...	Dhár ...	22 9 25	75 29 40	499	702
Manáwar ...	Ditto ...	22 13 56	75 7 46	659	2,597
Anjer ...	Burwáni ...	22 2 20	75 5 49	550	2,000
Ganwáni ...	Dhár ...	22 20 22	75 2 40	842	713
Khúrampúra ...	Ditto ...	22 1 18	75 23 14	667	227
Tikri	Ditto ...	22 3 42	75 26 35	640	844
Tonki	Ditto ...	22 15 15	75 9 20	703	269
Nimkhera... ...	Bhumia ...	22 26 27	75 14 8	1,464	79
Gújri	Dhár ...	22 19 14	75 32 53	752	.....

Bazars.

Bazars are held weekly at Nálchá, Bargúnda, Tikri, Dawána, Khúrampúrá, Bhikangáon Kanjersiuna, Bamjher, Chirwil, Bákaner, Manáwar, Datwára, Bárwái, Mota Mortaka, Anjer, Singána, Ganwáni, Mánpúr, Gujri, Haselpúr, and Jesarnagar.

Schools.

There are schools at Nálchá, Tikri, Manáwar, Bákaner, Mota Mortaka, Anjer, Mánpúr, Gújri, Surána, Mandwárá, Cheinpúr, Haselpúr, and Jesarnagar.

Police Stations.

Police stations are kept up by Holkar at Koselgarh, Bhikangáon, Cheinpúr, Barwái, Singána, Tonke, Haselpúr, and Jesarnagar, by the Dhár State at Nálchá, Gújri, and Mándo, by Scindia at Bákaner, Manáwar, and Ganwáni, and by the Bhumia chiefs at Rampúr, Dhál, Kankárdá, and Nimkherá.

Inhabitants.

The slopes and plateau of the Vyndhias are entirely peopled by Bhils. Unlike the residents of the plains, they have no regular villages, but live in isolated huts. These were found to be so numerous, that it was impossible to show them all on the field sections. Only therefore the hut or clusters of two or three huts, where the "Tarvi" or head man lived, have been laid down. The reason of their isolating themselves in this way appears to be so as to enable each man to have his patch of cultivation at his own door, instead of having to take himself and his cattle a daily distance to the same, and to prevent quarrels with their neighbours, to which they are very prone when intoxicated, as they often are. These Bhils of the Vyndhias are all cultivators; they also all own cattle, and are far better of both in physique and condition of life than their brethren in the Sátpúras, who go by the same name. They are a contented, happy and humerous race, and work well enough so long as they are sober, but are easily provoked and very troublesome to deal with when at all the worse for liquor, as they constantly are. They get drunk at all their festivals and remain for days in this condition, especially during the "Holi."

They are all armed with bows and arrows, both men, women, and children, and are good shots with these weapons. I used to meet whole strings of them thus armed on bazaar days when they take down jungle produce from the hills to sell or exchange for flour or ghee, and I was much struck with their open, hearty manners and humerous disposition. They take readily to Europeans, especially if they see that the latter care for sport, but it is seldom that any one goes into their country, so difficult is it of access.

Holkar's State Railway.

About 15 miles of this railway, or the portion between Balwárá and 3 miles South-East of Mhow, fall into the area surveyed this season by Mr. Wyatt in plane table 10. The ascent between these two places is 953 feet. The line takes a considerable detour to the North-West 3 miles away from Balwárá, in order to get the gradient of 1 in 100. It then runs parallel to the Mhow and Khandwá road as far as Chorar chouki, where it crosses the Chorar river and runs parallel to it and on its right bank nearly to the foot of the Bagorá Ghát. There are 5 miles then of very heavy tunnelling and other engineering works before the head of the Ghát near Bagorá is reached. Most of the bench marks along this railway have been laid down in the

maps of No. 2 Topographical Party, and the spirit level heights of the same agree well with the trigonometrical ones.

		Feet.		Feet.
Thus No. 16 bench height ...	By spirit level	=	1,111	
	„ trigonometrical value	=	1,135	diff. 24
„ „ 14 „ „ ...	By spirit level	=	1,098	
	„ trigonometrical value	=	1,088	„ 10
Bed of Nerbuddá river at Mortakka	By spirit level	=	507	
	„ trigonometrical value	=	508	„ 1
Bhanbardi B. M.	By spirit level	=	1,278	
	„ trigonometrical value	=	1,271	„ 7

There are many thousand men employed on the making of this line at present, but there is still a very heavy amount of work to be done on it, especially on the Chorar valley and Ghát section, before it can be opened to the public.

Roads.

Portions of the Agra and Bombay trunk road between Mhow and Khúrampúrá by the Gará Ghát Pass down the Vyndhias came into the season's work in plane tables 11 and 16, also a portion of the Indore and Khundwá road between Bárwái and Mortaka and Dhangáon and Dhorwá in plane tables 10 and 1. Also the made, though not metalled, roads between Dhár and Mánpúr, Dhár and Gújri, in plane tables 11 and 12, Mhow and Mandlesar *vid* the Jám Ghát in plane table 11, and a portion of the Rájpúr and Burwáni road between Talwárá and Talund in plane table No. 17.

The following are also good fair-weather roads, quite practicable for country carts :—

In plane table	1	Bárwái	to	Mandlesar.	
		Dhorwán	to	Beria.	
„ „	2	Khargún *vid* Chirwil	and	Bhikangáon. Khundwa.	
		Bhikangáon	to	Cheinpúr.	
„ „	1	„	to	Sundrel.	
„ „	3	Cheinpúr	to	Mitáwál.	
		„	to	Bhamnálá.	
		„	to	Mahomedpúr.	
		„	to	Khargún.	
		„	to	Sirsúd.	
„ „	11	Gújri	to	Máhesar.	
„ „	12	„	Lawáni	to Manáwar.	
„ „	„	Mándo	to	Lawáni.	
„ „	13	Amjhira	to	Manáwar and thence to Anjer.	
„ „	„	„	to	Ganwáni.	
„ „	12	Dhár	to	Dharampúri.	
„ „	16	Mahesar	to	„	
„ „	„	Bakaner	to	„	
„ „	„	Tikri	to	Anjer.	
„ „	17	Kukse	to	„	
„ „	22	Mahomedpúr	to	Pal.	

In fact most of the bigger villages or places where the "Kamasdars" reside are joined by rough country roads.

Notes on Mahesar Fort, by F. B. GIRDLESTONE, Esq., *Deputy Superintendent in charge, No. 2 Topographical Survey, Khandesh and Bombay Native States.*

Geographical situation.

This fort is situated in latitude 22° 10′ 14″ North, longitude 75° 37′ 44″ East, at the south-east corner of the city of the name belonging to His Highness Holkar in Nimar, on the left or north bank of the Nerbuddá river, and 766 yards to west of the junction of the Mahesri stream with the same. In a direct line it is 29 miles South-South-West of the British cantonments at Mhow, 27 miles West-South-West of Bárwái, the nearest railway station on the narrow gauge state line from Khundwa to Indore, and 53 miles West-North-West from Khundwa on the Great Indian Peninsula line.

Description of Fort.

2. The fort does not appear to have been built for offensive operations, but was constructed chiefly by Ailiabái, Queen to Kundirao Holkar, more as a residence for herself and courtiers. The foundations were commenced in 1780, and the last stone put to the present walls (which, however, are still incomplete on the southern face) in 1795.

3. As it stands at present, the fort is an irregular figure covering 33 acres of ground, and occupies a natural elevated site 106 feet above the bed of the Nerbuddá river. The mark stone cut by No. 2 Topographical Party in the centre of the flat roof of the high watch

tower built over what is called the "Gurhi Gateway" is 599 feet above mean sea level, and 146 feet above the base of Banesar temple, which is about the normal level of the water in the Nerbuddá during the cold weather.

Approaches.

4. The approaches to the fort are by two paved and very steep causeways on the north-west and north sides, at the top of which are gate-ways, inside each of which sentries are placed. Both these approaches into the fort are passable for wheeled traffic. The gateways are surmounted by watch towers which are loopholed for musketry. The passage through the gateway is about 12 feet wide.

Walls.

5. The fort walls occupy a length of exactly 1,500 yards. There is, however, a gap of 300 yards on the southern face still unfinished, which His Highness Holkar, it is said, is intending shortly to build up. The walls follow the shape of the elevated plateau on which they are built. To the north-west and north their summit averages about 40 feet above the level of the surrounding ground, and about 70 feet above that of the main part of the city. To the East they are 131 feet above the bed of the Máhesri stream; and to the South about the same height above that of the Nerbuddá. The actual height of the walls averages about 40 to 50 feet, and their thickness 12 feet.

6. On the north-west side the wall is supported by another solid lower one, of 11¾ feet thickness. This is really a buttress to the upper one. There is an upper parapet to the walls 4¼ feet in height above the flat terrace which is 9 feet in width. This parapet is loop-holed for musketry right round the fort. The musketeers would be well sheltered by the 3 feet thickness of the same.

Outer works.

7. There are no outer works, such as moats or ditches, or smaller fortifications of any sort.

Bastions.

8. There are 13 bastions to the fort. On three of these at the north-west, north-east, and south-east corners, there are circular masonry platforms, on which very large guns could be placed. The diameter of these at their base is 49 feet, and at their summits 30 feet. These are the main points of the fort which are intended apparently to be fortified, though there are no pieces of ordnance mounted on them at present, the guns on each of them would command the intervening length of wall or curtain between it and the next platform.

Whether commanded from other positions or not.

9. The position of the fort is well chosen. It commands the whole city, and is not overlooked from any higher site within 1¼ mile distance. The walls are all of very solid masonry, which is probably in as good condition now as ever it was. Both the stone and mortar appear to be of first-rate and durable quality.

10. The nature of the fort defences in the plan point of view is simply to prevent troops scaling the walls, or even approaching them within a distance of 1 to 2 miles, as the heavy ordnance on the 3 gun stands would completely destroy any force making such an attempt. They are not commanded by other works, and there is no ground within a distance of 1¼ miles to the north-west on which artillery could be advantageously placed by an enemy so as to bring its fire to bear against them. Where the gap exists in the walls on the southern side, an entrance could, of course, be easily made at present, and all the buildings within the fort could be easily shelled from rafts placed on the river, or even from batteries planted on the southern shore. There is never less, probably, than 8 feet of water in the river between Mandlesar and Singásád temple during the period from December to June.

Wells and water-supply.

11. There is only one well within the fort. This is situated about 50 yards South-East of the "Garhi" gateway. The water of this is bad and brackish, and on account thereof is not used by the inhabitants. It is 90 feet deep. There is no machinery either for raising water from the Mahesri or Nerbuddá river. There are no public store-house or granaries in the city, but some of the Rajah's dwelling rooms round the Ailiabai palace could easily be made available for this purpose.

Armament.

12. Of ordnance within the fort there are 30 pieces in all, of which nine are iron, about 9 feet in length, and capable of carrying a ball 6 inches in diameter. Seven others of 4 feet in length, also of iron; all these are old, worn and honeycombed. There are also five brass howitzers of 3 inches in diameter at the muzzle, one new brass gun 4¼ inches in diameter at the muzzle, seven small ones 2½ feet in length, and two other very small ones used for firing salutes to the gods when carried about at the various religious festivals. Of these guns 14 are mounted on carriages for field work, and moved by bullocks. All these appear to be in good order and thoroughly serviceable.

Ammunition.

13. Within the fort is a room, 21 feet in length and 33 feet in height, filled with gun-powder, as well as with the materials for making the same, *viz.*, sulphur, saltpetre, and charcoal.

14. The garrison, when the survey was going on, consisted of 135 sepoys, 40 policemen, and 40 sowars with horses; all these were armed with old pattern and very unserviceable looking muskets and swords of sorts.

Garrison.

15. The country round the fort is a mass of intricate ravines from 50 to 120 feet in depth, and extending from the river inland some 500 to 700 yards. To North of this broken ground lies the main part of the city, which contains about 10,090 inhabitants, and extends for about ¾ of a mile to West, North-West, and North, and covering about 450 square acres of ground. Outside the city the country is covered with large topes of mangoe trees, and numerous gardens separated from one another by high and thick hedges. There are three good fair-weather roads leading out to Dhárampúri, Gújri, and Mandlesar, respectively. None of these are bridged.

Description of surrounding country.

16. Within the fort are a mass of buildings. These are principally temples and the residences of the priests employed in service thereat. The place is a perfect labyrinth of narrow streets or gullies, and troops would have much difficulty in getting about them. The whole of the south side of the fort is taken up with the Ailiabai palace and several splendid temples attached thereto. They are very handsome and massive stone buildings, highly sculptured, with fine ghâts extending for several hundred yards along the river bank.

Interior of Fort.

Extract from the Narrative Report of LIEUT. T. H. HOLDICH, R. E., *in charge of No.* 3 *Topographical Survey, Central Provinces and Vizagapatam Agency.*

[Madgul Golgonda and Rampa Talooks.]

Description of the country triangulated.

Dumagudiam, the point from which the triangulation started, is a very small and insignificant station on the Godavery, called into existence by the Godavery navigation works, and if only these navigation works are carried on to completion, Dumagudiam may yet have some small commercial future before it. At the time I visited it, however, the navigation of the river was suspended, and one of the two Europeans whose fate has deposited them in this locality had been sent elsewhere to hunt for coal. To the survivor (an energetic, hard-working missionary) I was indebted for much interesting information concerning the tribes of the surrounding districts. Starting from Dumagudiam in a northerly direction, I traversed the same route as that taken by Colonel Haig some years ago when looking for a practicable route from the river at this point to Jeypoor. In the immediate neighbourhood of the river (districts already surveyed by the Hydrabad Survey Party) there was considerable attempt at cultivation, with large and flourishing villages; but after passing Bodanalli, we were at once involved in the Bustar jungles. Probably no continuous jungle of the same character and extent exists elsewhere in India As I have already stated, the general level of the country is low, from 200 to 300 feet only above sea level, while huge shapeless masses of hills rise here and there abruptly from the plains to as much as 2,000 feet above the general level below. From the highest of such hills it was, of course, possible to obtain a very wide and extensive view of the districts around, so that not only the area of country already triangulated, but a very considerable stretch of jungle, northwards towards the Indrawatti fell under actual observation. The view from any one of these hills was the same as from all the others—one vast unbroken sea of jungle stretching around as far as the eye could reach, with the gigantic forest trees and rank-grass undergrowth dwarfed from the height on which one stood to the appearance of a perfectly level open plain. Hills were scattered about in plenty; but unless high enough to break the horizon line, it was frequently only when they cast long shadows in the evening that they were descernable at all, from the perfect uniformity of the forest-jungle which covered and surrounded them. In the early mornings the grass and trees were usually soaking and dripping with dew, and as the dew gradually evaporated and again condensed into clouds, a huge white mantle was evenly spread over the face of the jungle, and then there appeared, breaking through the mantle, the tops of innumerable little hills that it was perfectly in vain to look for later in the day, when their outlines were hopelessly indistinguishable from the surrounding mass of forest and grass. The long white thread of the Godavery appearing here and there was almost the only break in the scene; at one place only (Jiggergonda) was there cultivation sufficient to be discernable in the jungle from the surrounding hill stations. The route I followed was the only northerly route that can be followed through the jungle. The road was good enough as far north as Chintulnar; it is used by the Banjaris (whom, by the way, I never happened to meet anywhere) and for hauling teak timber to the Godavery. Villages are few and far between, though all that there are are capable of supplying a camp with rice and fowls. There is at times a scarcity of water in the neighbourhood of Yelmagonda; the soil is sandy, and what water is procurable appears to be good. With the exception of Chintulnar and Jiggergonda, the villages which I visited consisted only of one or two huts, and were in some cases completely deserted. A very slight cause is sufficient in these districts to ensure the complete desertion of a village. A visit from a man-eating tiger, or one year's failure of the poor little crop surrounding the few huts, is quite enough, and the village is abandoned to be burnt off the face of the land by the next jungle fire that passes that way. I found it quite impossible to arrive at any sound conclusion as to whether there has been

of late years an increase or a decrease in the population of this jungle. I noticed so frequently (sometimes in the densest part of the forest) unmistakable signs of the recent existence of villages, that it seemed to me at first that there must have been a very considerable exodus from the country, or that the population had in some other way become very rapidly thinned. But this little peculiarity of changing the site of a village on the smallest provocation quite upset any calculations on the subject, and though I still think there has been considerable emigration to the river provinces, I doubt whether there are actually fewer villages in existence than there were ten or twenty years ago. The village huts are very neatly put together with bamboo mat sides and grass thatch, with a good, serviceable split bamboo palisading enclosing each of them as a protection against leopards and tigers. Passing northwards from Chintulnar and following the principal Banjari route towards Jeypoor, a rough but not very steep ghât ascends to the plateau, from which rise the hills near Gogonda H. S., the western and south-western limit of which is the Bailadila range. With the ascent a very pleasant change in temperature is immediately experienced, and the monotonous nature of the jungle scenery is agreeably diversified; but the roads are almost impassable, and in order to move freely it was necessary to have the main camp standing and to work on foot. The Bailadila range rises to 4,000 feet above sea level. The top of the range is above the level of jungle growth. Bare-looking grass covered submits, with an out-crop of loose blocks of conglomerate intensely fatiguing to walk over, are the main features of the hills. There are here and there striking bits of scenery, but the general effect is too monotonous to be pleasing. The vegetation of these hills near the summit of the range differs essentially from the rank growth of bamboos and cane at the foot. The most noticeable trees were those called by the natives Sāz or Sāzu (not unlike Mhowa, with white underleaf), the gingeli trees, and a pink flowering shrub, (the leaves of which were eaten by the people) called *gille*. The ascent is steep and difficult. We found water at the summit, but no vestige of human habitation. The objection that the natives show to ascend these hills is doubtless caused by the cold experienced at the top; the guides and coolies collected for work all deserted during the first night passed there. From the Bailadila hills southward and west of the Chintulnar and Jiggergonda route the nature of the forest was precisely that already described. Being untraversed by any main route it was at times exceedingly difficult to move the camp to any point within reach of the hills selected as trigonometrical stations. Now and then it was necessary to abandon even the narrow tracks that lead from village to village, and to push across the jungle from hill to hill. The difficulty of making way through the dense grass in any thing like a direct line, and the intense suffocating heat experienced when buried in the jungle out of reach of the passing wind, made almost any coarse preferable to this: so that frequently two days were sacrificed to a short direct move from one station to another, and moreover it was found that even the villagers of this district were often completely at fault as guides through the everlasting sea of grass which totally obscured the view of even the nearest hills. The utter stillness and want of sound in these jungles is sometimes quite oppressive. Yet this is not at all due to any want of animal life. Tracks of buffalo were frequently observable in the low lands, and bison in the hills about Bailadila. Sambur and smaller kinds of deer exist but not in large numbers. I believe there are no species of antelope in the Bastar jungle at all. Wild pigs are very numerous in the hills and the boars grow to a gigantic size, but the most frequent tracks observable by far are those of tigers and panthers. The dread of tigers is very great among the villagers, and it is impossible here, as in the hills further east, to persuade any one to travel singly along even the most frequented routes. The grass is beaten down as far as possible on either side the main Banjari roads, so as to give a little more chance of observing the enemy in time; but, as a rule, the tracks are the merest footpaths through the grass, hardly distinguishable, and no doubt very dangerous in this particular. I so frequently observed the tracks of tigers (sometimes as many as three distinct animals) over the foot-prints of the lascars and people who had gone on ahead of me in the early morning, as to feel convinced that they were often quite close at hand, although most securely hidden, and so I never attempted to break through the very inconvenient system in these parts of always sending two or three men in company.

Description of the country mapped.

The country brought under topography this season differs most essentially from that triangulated; part of the districts of Golgonda and Rampa under the Narsipatam and Rajamundry Collectorates comprised the whole season's outturn. The parts surveyed consisted entirely of the broken rugged hills which continue the mountain system of the Eastern Ghâts, and, extending across the Godavery river, with a general south-westerly trend, finally merge into the high plateau of the Hydrabad country. The general system is, of course, that of a range of hills running north-east and south-west; but beyond this there is a strange want of that natural arrangement of parallel ridges generally found in other ranges. A look at the completed maps will show flat-topped, irregular-shaped hills, narrow and scarped ridges, and level spaces dotted with isolated peaks, all mixed up in apparent confusion, and the result of this is a most unusual amount of detail among the smaller natural features of the country. It is, as a rule, a densely forest-clad district, the higher peaks only (which rise to about 4,000 feet above sea level) standing out at sufficient altitude to be clear of dense undergrowth, and marking the distant landscape with their square-cut yellow grass covered tops, with an effect that is a good deal more strange than beautiful. The change of climate from the lowlands of the Bastar jungle was most refreshing, and the luxuriant beauty of the villages here and there can be compared to nothing south of the Himalayas. The most marked trees among

the jungle are wild mangoes (whose young leaves in March were of the most brilliant hues), bamboos, palm trees of several varieties, and the graceful tree ferns. These, massed and knotted together with strange creepers and many other wild tropical plants unknown to me, presented effects of scenery pleasant enough to look upon, but most unpleasantly obstructive to the advance of the survey. At one point of the Godavery where the main water-shed of the Eastern Ghâts is broken through by the river which passes by a narrow and almost unfathomable channel called "the gorge," the scenery is so striking as to well merit a visit from all tourists and travellers in this part of India, and it will be easily accessible by means of the shallow steamers that are for the future to navigate the Godavery during those months of the year when there is water sufficient to float them. From this it may be gathered that the country presented unusual natural difficulties to the surveyors; add to this the difficulty of obtaining supplies, the scarcity of villages, and consequently the daily recurring difficulty of collecting guides and coolies enough to show the way from the villages to the hills and to clear the jungle before the plane table could be fixed in position, and the rather limited outturn of the party is easily accounted for. I have the authority of the oldest surveyors in this party for the statement that it is by far the worst ground that they have as yet encountered. I wish I could say that, once out of these hills, their difficulties will diminish; but I fear it is rather the other way—all these districts are notoriously malarious. The attempt to establish police stations has almost entirely failed from this cause, and it is only under the pressure of duty that any European official connected with these districts will ever pass into them at all. The Europeans of the party suffered continually and have continued to suffer since leaving the field. There were not many deaths among the natives while actually in the field, but it can hardly be doubted that some of them left the field in a condition that will effectually preclude the possibility of return. All these hills swarm with game, of which bison and tigers are the most prominent species. The damage done by tigers is almost incalculable. Dozens of villages have recently been deserted on their account, and the superstitious dread they inspire is such that all tigers are regarded as deities supposed to have superhuman powers of recognising those who speak lightly of them and of punishing informers. No combined attempt has as yet been made to meet this great evil, but as things stand it almost looks as if the tigers would eventually take possession of some of the best localities altogether. I think there was not a single surveyor who was not more or less obstructed and annoyed by these brutes. Mr. Adams lost one coolie in returning from work, and had a visit paid to this camp by a tiger in the full light of noonday when most well-conducted tigers are supposed to be asleep. Yet the density of the jungle and the nature of the ravines render anything less than a well organised beat a hopeless attempt at dealing with them, and the villagers hereabout are too much panic-stricken to take any share in such beats. One well known old man-eater was pluckily attacked and beaten to death by the villagers of Lamsingi, but I heard of no other such performance. This one was, I think, once well known in that bit of country which Mr. May was compelled to leave unsurveyed last year.

Inhabitants.

The inhabitants of the triangulated part of the Bustar jungle may be broadly classed under one head—Kois. The Koi is an aboriginal tribe of the Dravidian (or Gond) family, somewhat allied to the Telingas of the Godavery districts on the one hand, and to the Gond tribes of the plateau about Jugdulpore (or Bustar) on the other. They imitate the Telingas in their customs in the southern districts, but admit no relationship whatever with the Gonds, though the relationship exists. Very little is known of the aboriginal tribes in the Bustar jungles. As far as my own observations went, I was unable to identify any one man of any other tribe than that of the Kois, although the Gotta or Gottawar tribe and the Maria are stated to be distinct tribes occupying some of those districts through which the season's triangulation extended. Even from such native officials as were deputed by the Bustar Raja to attend my camp could I discover that there was any tribe other than the Kois, from which I infer that the Kois are by far the most numerous, as they certainly consider themselves the most important, tribe in the low districts west of the plateau. The language of all these tribes being very nearly identical, it would be difficult to distinguish them apart; they all understand Teligoo. In the more southern districts included in the Beji, Kotapili and Chiatulnar taluks, I observed no stone monuments or anything to denote the burying places of the people; further north in the Chintulnar taluk, immediately the Ghâts were ascended to the plateau, on which stands the Bailadila range, such evidences of burying places were common. Slabs of gneiss eight or ten feet high were placed in upright rows always along the edge of the road as far as I could see, and sometimes at the foot of them would be a smaller slab horizontally supported on four little round boulders. The burning places and burying grounds were side by side, but the burning place was almost invariably overshadowed by the mohwa tree. The fact of the burning and burying grounds being close together would seem to identify the tribe hereabouts as the Marias. It is stated in the ethnological report of the Jubbulpore Exhibition of 1866-67 to be the custom of the Marias to bury their women and children, but to burn their men, binding the corpse upright to the foot of the mohwa tree. It is also more especially their custom to erect the monuments described. Yet the villagers on this plateau answered to the name of Koi just as did the people below, and in more than one instance distinctly refused to admit the name of Gond or Maria. The Kois are a small but well made people, generally dark-colored but not universally so, much given to red and white bead ornaments round their necks, and wearing their hair knotted up behind in a manner suggestive of the chignon. As a rule, they are effeminate in voice and appearance, having little hair

on their faces: but I saw a few instances of very well developed beards. They appear to be generally truthful, honest, and are decidedly cheerful, but have very little idea of doing a hard day's work, and will dismantle a village and depart with it elsewhere, or burn it on very slight provocation. They occupy themselves as little as possible in agriculture, and as much as possible in tending their herds of cattle as a pursuit much more congenial to their disposition. The tribes of the Godavery districts and throughout the Rampa and Galgonda hills are Telingas of two castes, a high caste (called Reddi) and a low one; the latter will eat any sort of flesh, or even carrion. My attention was called to the fact that among the Telingas of the hills there were scarcely any old men. Life seems peculiarly short to these people, and truly their lot is cast in a land as little favorable to longevity as can well be conceived. This is not at all the case among the Kois and Marias. I saw many an ancient specimen of humanity, evidently well tended and cared for, on whom the feebleness of old age had fallen, carried out and propped up against the door of the family, but with just vitality enough to smoke a hookah and blink feebly at the bright sunshine.

Of wandering tribes, the ubiquitous Banjari is, of course, to be found following his trade through all these districts, and to the Banjari the inhabitants may be thankful for the only practicable roads they possess. Other wandering tribes are hardly represented at all in the jungle, though they may be found and studied to great advantage all along the banks of the Godavery.

The Erukalavandlu is a small wandering tribe, of which members are found just on the edge of the Bustar jungle in the neighbourhood of Dumagudiam. They form small encampments in the neighbourhood of a village and remain fixed for some time, employing themselves in mat-making and fortune-telling. The peculiarity of this tribe lies in certain observances at childbirth: the father takes the place of the mother in bed immediately before and after the child is born, and the usual medicines are given to him, instead of to his wife. During the subsequent period of uncleanness he is treated as is the usual custom with Hindu women. Probably no district in India offers such opportunities of becoming acquainted with varieties of the aboriginal tribes of the Gond family as the Telugu speaking districts of the Godavery valley, but a few miles only from the actual banks of the river this mixture of tribes ceases altogether.

Extract from the Narrative Report of CAPTAIN R. V. RIDDELL, R. E., *Deputy Superintendent in charge No. 5 or Bhopal and Malwa Topographical Survey.*

Country triangulated and described by H. Horst, Esq., Assistant Superintendent:—

"The ground triangulated extended over an area of 1873 square miles of hilly country, the greater portion covered with jungle and presenting considerable difficulties to reconnaissance. Several stations of the Gwalior party, *viz.*, Bájna, Shampura, Malpura and Tanod, were conveniently utilised and connected by symmetrical figures with my own work. The computed values of common sides agree most satisfactorily. The cantonment of Augur, occupying a central position in the area under triangulation, and the head-quarters of the Political Agent for Western Malwa, I found most convenient, and duly record my thanks for the valuable assistance rendered me during my operations by Major Martin, the Officiating Agent.

"The Western Malwa Agency includes portions of Gwalior, Holkar, Jhalra-Patan, Alot and Sitamau, an independent sub-division of Gwalior. The principal towns are Augur, the head-quarters of a Subah and Tehsildar; Susner, a tehsil; Nalkhera a tehsil, and Shájapur or Shajehanpur, also the residence of a Subah, all in Gwalior; Gungrar, the residence of a Nazim, a walled city, in a very dilapidated condition, situate on the right bank of the Chota-Kálisind river; and Dug, a Nizamat in Jhalra-Patan; Shajapur on the Agra and Bombay road, contains a dák bungalow, and post and telegraph offices.

"The country where cultivated is extremely rich and intersected by several large streams, water being invariably found near the surface.

"Opium, found to be the most profitable, is the principal product of cultivation, and, as a natural consequence, the prices of grain of all kinds run high."

Country plane-tabled.

Of the country plane-tabled, the greater portion lay in Bhopal territory, the northern sections being, as a rule, open and well cultivated, those to the south hilly and covered with jungle.

The subjoined statement shows the comparative areas of the various States and the per centage of cultivation to waste land:—

	Total area.	Cultivation.	Percentage.
Bhopal	2042·1	813·2	·39
Gwalior	60·5	26·7	·44
Rajgarh	264·9	124·3	·47
Narsingarh	207·3	130·5	·63
Maksudangarh	61·5	24·7	·40
Touk	82·0	2·6	·03

Compared with that of last season, 46 per cent., the general proportion of cultivation exhibits a slight decrease, falling to 41 per cent., mainly due to the large tract of hilly country over the Nerbudda valley included in the present year's work.

The total area plane-tabled, amounting to 2,812 square miles, gives an average of upwards of 270 square miles to each of the ten assistants who completed a full season's work. This result may be considered satisfactory, and compares favorably with the outturn of previous years.

Hills.

As in the published sheets of last year the Vyndhia range forms the most prominent feature, entering the season's work about the parallel of 23, and running in a south-westerly direction, with a well defined scarp on the southern side as far as the meridian 77° 45′, immediately to the North of Hoshangabad; at this point the hills immediately overhang the valley of the Nerbudda, the intervening country being very much broken up by small streams running South, and numerous spurs more or less detached from the main range.

The general elevation is about 2,000 feet, and the height of the hills above the bed of the Nerbudda about 1,100 feet.

Beyond Hoshangabad the range again recedes from the river in a westerly direction, minor spurs running north to form the watersheds of the Betwa, Bes, or Hulâli, and Parbatti rivers.

On the northern side the fall is comparatively slight, and the general level of the country as far as Bhopal and Sehore is about 1,700 feet.

In the sheets to the north of Bhopal a low range of hills overhanging the city of Nursingurh forms the only prominent feature, but immediately above the parallel 23° 45′ the watershed assumes a more marked appearance, and on both banks of the "Parbatti" the ground is very much broken by irregular groups covered with jungle and rising some 300 or 400 feet above the surrounding country.

Rivers.

The principal rivers met with are the "Nerbudda" forming the boundary of Bhopal and British territory on the south, and the "Parbatti" rising in the Vyndhia range on the north.

Nerbudda River.

The general width of the Nerbudda is about 500 yards, increasing here and there to 800 yards. The river falls about eight feet per mile; the banks, about thirty feet in height, are steep and well defined, and the bed sandy and free from rocks.

It is fordable for the three months preceding the rains near the villages "Bagwára," "Namnagar" "Garjalo," "Ninor" "Pathaora," and "Tigaria," all to the East of Hoshangabad, and crossed during the same distance by nineteen ferries, the principal of which are at "Chichli," "Josipur" and "Hoshangabad."—Its principal tributaries on the south are the "Tâwa" and "Hather," the former joining it about 5½ miles north-east of Hoshangabad, the latter two miles south-east of the large village of Mardánpur.

The streams from the north all rise in the Vyndhia range, and having small drainage areas are comparatively insignificant. The largest of these are the "Dhobi" and "Bhaguer." The only considerable rapid is the "Bandraban" near the junction of the "Tâwa"; but two miles east of Mardánpur there is a fall of about seven or eight feet.

Parbatti River.

The "Parbatti" rises in the Vyndhia range near the village of Magarda and enters the season's work near the village of Manakhera about six miles north-west of Sehore. Its general width is about 250 yards, and it is fordable throughout the greater portion of the year. The banks are about twenty feet in height, and the river bed mostly composed of clay, and in places very rocky. The fall is about two feet per mile. The principal feeders are the "Párna" "Patpura" and "Tem" all on the right bank. Other streams of minor importance are the "Sukar" a tributary of the "Newaj" one of the main feeders of the "Chumbal." The "Bue," "Halali" and "Kalisot," all eventually finding their way into the "Betwa."

Cities

1.—Bhopal.

"Bhopal, the capital and seat of government of the State of the same name, occupies a central position in the season's work.

The following description extracted from Captain Riddell's introduction to the computations of the large scale plan completed during the season 1872-73, may be of interest:—

"The city of Bhopál is overcrowded, at least that portion within the walls, the streets and "lanes of which are mostly narrow. There is no attempt at pavement or Macadam. Yet in "one respect the city of Bhopal has an advantage which I have never seen in any other "Indian city, *viz.* at various places all round the inside of the city wall, and also in some "of the principal streets, excellent water is obtainable to the population by the simple process "of turning a tap. At the southern side of the lake the puffing of an engine may constantly "be heard. This engine is a steam force-pump which forces the water of the lake into a

"reservoir about 150 feet above the surface of the lake; from this reservoir a large pipe conveys "the water into the city; and the height of the reservoir is just sufficiently high to admit "of the water being carried into the upper fort; the level of the water when the reservoir is "full being about ten feet higher than the level of the ground at the gateway of the upper fort.

"The two lakes are divided by a narrow neck of land, partly natural, and partly artificial, "and though I believe communication between the two lakes can be effected, yet for a great "portion of the year there is none, for I found a difference of level of sixteen feet between "the surfaces of the lakes in the month of January, when I made the observations for the "triangulation necessary for the large scale survey. The lower or smaller lake depends for its "existence entirely on a masonry dam at its northern extremity; the ground at the northern "side of this dam must be about thirty feet below the surface of the lake: should the masonry "give way, the water of the lake would collapse and clean a place which is at present an eyesore, "and ought to be a source of disease. Over this dam lies the thoroughfare between the "city and that portion of the suburbs known as Jehangirabad. In Jehangirabad all the troops "are quartered, except the few which guard the fort, and these latter form no part of the "regular troops (if the name may be applied to them.)

The population is about 44,000, but this estimate is probably below the true figure and only includes the permanent inhabitants. A description of the fort of Bhopál accompanied the Narrative Report of last season.

"Nursingurh."

Nursingurh, the capital of the independent district of the same name, is situate on the left bank of the "Parbatti". It is commanded on the western side by a detached group of densely wooded hills rising some 300 feet above it. The population is about 9,000.

The city itself is partly walled, and in the centre there is a large tank with necessary sides filled by a small stream from the adjacent hills. It is approached by roads from "Beaora," "Devipura," and Sajpur, and has five entrances. The distant view from the western side is extremely effective.

The following description of the fort is furnished by Mr. Hamer:—

"The fort of Nursingurh is built on a hill rising to a height of about 300 feet "immediately above the town on the east side. It is about 900 yards in length from North "to south, and 500 yards from east to west at its southern extremity, decreasing to 340 "yards about the centre, and to fifteen yards only at its northern end. The highest part of "the hill is about the centre, shelving down on all sides to the precipice which is continued "all round the hill. There are only two roads leading up to it; the first on the western side "of the hill leading from the town to the palace, a paved road about ten feet wide, but very "steep; practicable for elephants; the second on the northern face of the hill which was "under construction at the time of surveying, will be a much better road, having a gentle "slope from the foot to the highest part of the hill. A low wall about four feet high and "two feet thick is built on the precipice all round the hill. No guns were to be seen on the "walls, though the Raja has nine or ten brass cannon kept in a shed contiguous to his palace.

"Sehore."

Sehore, the residence of the Political Agent and head-quarters of the Bhopál Battalion, is about twenty miles distant from Bhopál. It is approached from the latter place by a metalled road, and another main line of communication enters the city from Indore on the southern side. It is watered by the Siwan, a tributary of the Parbatti, but at this point a comparatively small stream. The population is about 19,000. There is no fort or walled protection of any description, and a large proportion of the buildings is of a temporary character. The triangulation for the large scale plan of the city was completed during the past, and the detail work will be completed during the coming season.

Roads, Passes, &c.

Metalled roads exist between Bhopál and Sehore, and for a comparatively short distance between Sehore and Indore, but the majority of the communications consist of fair cart tracks only, and, as in other parts of Central India, little attention is paid to repairs or the removal of natural obstacles. Numerous tracks cross the Vyndhia range on the south, but few of these are available for carts, and the majority of them are impassable to laden animals. To the east of Hoshangabad the only pass available for camels is opposite the village of Hura, being a continuation of the road crossing the Nerbudda at Garjalo, and eventually reaching Chandpura through the valley of the Jamner.

From Hoshangabad to Bhopál a good road available for wheeled traffic crosses the Nerbudda immediately opposite the village of Josipur by a ferry, and passing up the valley of the "Gadária" a small stream, ascends the ghât by a made pass to Choka; thence through Kaliakeri and Bhojpur, where there is a ford across the "Kaliasot" to Bhopál.

Further west there is an alternative route crossing the Vindhias at the Murum Ghât.

It is practicable for carts of all kinds, but no drinkable water is procurable.

The most celebrated pass is the "Delawári," four miles west of the Murum Ghât, in the direct line of communication between Bhopál and the large village of Mardánpur.

At the foot of the ascent there is a spring of good water, and the ghât is one of the best in Bhopál. The fort of Ginorgarh commands the road from the ascent to the village of Kanpura. This pass could be well defended, and is accessible to traffic of every description.

Another good pass is the Kót Ghât, four and a half miles further west. The ascent is about 300 feet, and there is a spring at the foot of the hills, but the water is barely drinkable.

Extract from the Narrative Report of CAPTAIN W. F. BADGLEY, *in charge No. 6 Topographical Survey, Khasia, Garo and Naga Hills.*

Remarks on the country surveyed.

The country surveyed by the party was partly in the Manipur and partly in the Naga Hills District; between these to a certain distance rises a range, the Barrail, averaging from 8,000 to 10,000 feet in height, and giving off on both sides spurs and minor ranges which run in a general N.-N.-E.—S.-S.-W. direction. This large range, the origin of the Gáro, Khasia and North Cáchár Hills, runs from Assálu to south of Kohima on a N.-E. line, and there abruptly end in several precipitous peaks. The watershed, however, of the rivers flowing into Assam and Manipur is continued from it in a S.-E. direction to the Kopamedza range, whence branch two lines of watershed, the Kopamedza having the general N.-N.-E. direction of all the minor ranges forms the watershed between Assamese and Burmese waters, while a range running S.-E. to the hills overlooking Burmah is the watershed between the waters of Burmah and of the Manipur valley. Bounded West and South by these two watersheds and East by high N.-N.-E. ranges, of which Sárámeti, 12,600 feet high, is one of the highest peaks in the Lániere valley, the northern limit of which has yet to be surveyed. Between the spurs from the South of the Barrail and of the watershed to the Kopamedza rise the Bárák which flows past Cáchár and its tributary streams. East of the Kopamedza range to the Shiruifarar peak, the Iril which flows past Imphál, the capital of Manipur, and the Tabalturel drain to the South, the hills of which the Laniere and its branches drain the northern slopes. East of Shiruifarar the waters flowing South are in Burmáh from their source. In the Barrail on the north from the boundary of North Cachar to Kohima, are the source of the Dhansiri River, and between Kohima and the Kopamedza rise the Siju and Zullo, which, joining to form the Doyong, fall into the Dhansiri above Golaghát.

The northern spurs of the middle part of the Barrail end rather abruptly about fifteen miles from the ridge, and between this line, on which the station of Sámáguting, at a height of 2,477 feet is situated, and the Rengma Hills and Golaghát, is a broad, pestiferous forest-covered plain through which wind the Dhansiri and the latter part of the Doyong Rivers. This forest, which has been inhabited populously in places, as at Dimápur, where there are remains of a fortification or palace of about ·15 of a square mile (96 acres) in area, and many fine tanks, is now occupied by a few wretched villages, two riding paths and some police-men, the population in comparison to square miles of area being less than one to one. In striking contrast to this is the populousness of the Naga Hills, especially to the East of Samaguting. From one point sixty villages, some of them of more than 600 houses, could be seen, and the population roughly calculated amounts to more than ninety to the square mile, and the people seem to be on the increase, notwithstanding their quarrels and blood feuds.

Having explained our plans to the leader of the expedition, and succeeded in inducing him to aid the survey of the Doyong to the Lániere exploration, which was all he at first contemplated, on the 1st of January the camps of the Political Agents of the Nága Hills and of Manipur with Captain Badgley and Lieutenant Woodthorpe marched from Kohima. Our route lay northward along the spur, which running N.-N.-E. from Jápro peak at the east end of the Barrail range, ends in the hill called "Woka" by the Lota Nágás who live on it, and "Thebzothin" by the Angámies. The Doyong flows on the eastern side of this ridge, and circling round its northern end cuts it off from the hills further north. On the 2nd we set up a new mark at Nidzokru H. S., and on the 3rd camped at Themokadima. We had left the Angámies, had passed through two half Sema villages, and were now in the Rengma country.

Our next day's march was to have been to the next Rengma village, Tesephima, but in the morning various rumours came in; at first our men sent on in front had been killed, but finally that the Tesephimas would not either let us into or pass their village, their message being bombastically worded to the effect that as neither man nor tiger had ever been allowed to pass, neither should we. But little was thought of this, however, and we started to try to induce them to receive us, taking sixty men as a precautionary measure, and as the sight of them might induce them to admit us more readily and cheerfully. More than a mile from the village we found the path and jungle thickly set with those little bamboo lancet like darts called "panjies," the Native Officer of Police getting one through the leg, and by the time we had reached the village, though we crawled along most slowly and cautiously, four men had been lamed by them.

Tesephima is finely situated for defence on a height at the junction of three ridges. The hill is precipitous on one side, steep on all, and approached on our side by a narrow rocky neck,

above which rose the steep ascent to the village with the precipice on our right. At the neck they had made a breast-work of earth and stone, where, with guns or even arrows, they might have given us more than we would have cared for, but they did not attempt to defend it, perhaps as a stratagem to induce us to rush on too boldly and fall into their trap of a flank attack, repulsed by which they might hope to have us at a disadvantage among the "panjies,"—which, and the ground in front of it were studded with. They retired steadily with a chorus of two deep sounding notes which had quite a grand organ-like thrill very different from the cackling jackall-like war cry of the Angámies.

What happened was very exciting while it was going on, however much we might pity the unfortunate people after it was over, and there is this to say that they brought it entirely on themselves, rejecting every overture for peace or conference, and leaving us no choice but to attack them. Halting at the breast-work for a minute, interpreters were put forward to try to induce them to come to terms, but they were answered with the war-cry alone, and we advanced up the slope crowned by the village which was protected by zig-zag approaches, stone-walls, hedges and clumps of bamboo. They probably had not expected us to be so quick, for we were in their lines before the flanking party showed, which thus became a rear attack; and now, if they had only stood, or if both had rushed in, they might have done something and we something worth writing about; but our guns frightened them. They gave way at once, without, I was going to say, throwing a single spear, for, though I am told spears and stones flew about promiscuously, I saw none myself, and we never stopped till we were in the village. Here perhaps a little recovered from their fright, they made several attempts to advance, but always to be driven off with loss, and at last gave it up, so that at about 3 in the afternoon finding nothing to do, we returned to camp. Before we left, Lieutenant Woodthorpe, who had been out surveying, joined us sorry to have missed the affair, bringing with him fortunately his cold breakfast, which we were glad to help him to dispose of, the excitement having had a good effect on our appetites. Dr. Brown had meanwhile kept the camp at Themokadima; no attack was made on it, the two villages being at war, though both Rengma. Many of the Themokadimans, indeed, went with us (perhaps to take advantage of either event) and looted and set fire to Tesephima, burning down a third of the place. Twenty-two of the poor wretches were killed, and two or three died afterwards; our loss was four men lamed by panjies.

Halting on the 5th to give them time to come to terms, we marched again against them on the 6th. They now occupied a hill two miles from their village. We held a parley with them; women with bared breasts and the green bough of truce acting as heralds on both sides. They declared they would resist, but whether it was a mere demonstration, or that they lost heart at the sight of the red coats of Dr. Brown's escort, of whom he brought ten with us on this occasion, or from whatever cause, we reached the village without meeting any opposition, excepting from "panjies" by which again two men were wounded. Near the village we were met by messengers of peace, which, after the payment of a fine, was concluded in the village and we marched back again.

The next day we encamped at Tesephima, on the 8th at the Lota village of Phurma, and on the 11th at Woka, halting on the 10th at Nongsee Close to Woka; to the east rises the Woka hill, 6,500 feet in height and about 1,500 above the village. Here we cleared the hill top and put up a signal for a station, but without being able to make use of it, for the rain came down, or clouds hid the view, till we at last gave it up, and on the 14th marched west towards the villages, also Lotas, on the opposite side of the Doyong. They were a sullen lot at Woka, the most vile of all the Nágas we saw; they would neither fight nor act peaceably, nor sell us food, though the money would have been a benefit to them, as they knew its value and could use it in trading with the plains.

Camping on the 14th on the Doyong, 15th at Morákcho, 16th on the Doyong where it turns west to leave the hills, and 17th at Phurma, we completed a circuit to the west which brought us back through Tesephima to Themokadima on the 18th. In this short time most of the houses at Tesephima had been rebuilt, and we found the inhabitants quite friendly and seemingly taking what had happened to them quite as a matter of course. On the 19th Dr. Brown with his escort, &c., and the sick men marched for Kohima. Some difficulty had been found at times in feeding so large a camp; any question as to the direction of the outfall of the Doyong having been settled, there was no occasion for him to accompany us on the round we proposed to make westward across the Doyong, up its eastern side and across westward again to Kohima.

On the 20th we marched through Tesephima again to Kotsobagwema, on the 21st to Kite, 22nd across the Doyong to Goshitomi, and 23rd to Káken-agámi. At Kite, which, with Sámpui and Roki close to it, are Sema-Nága, villagers turned out to oppose us panjying the path, but a crowd of Rengmas, who had followed us from Themokadima, hoping for a quarrel that they might pick up some plunder, as they had done at Tesephima, having been driven back, and the Semas having been assured that we were friends, they pulled out the panjies and treated us well. Here we were again in danger, not of a quarrel, indeed, but of leaving a bad impression from some of the interpreters and followers doing a little private pillage, but they were discovered, the plunder returned, and themselves made examples of.

The Doyong where we crossed it, east of these villages, is deep enough for canoes, but whether navigable from below I cannot say. Where we saw it on the opposite west side of the Woka ridge there was ample depth for boats of some size, but we heard that there was a ridge of rocks or some such barrier which prevented boats of any burthen from going far: where this was, I am sorry to say we did not ascertain. The Nágas do not use boats. On lines of traffic where the rivers are too deep to be forded in the rains, they have cane suspension bridges, similar to those built by other hill-people in India.

Above Káken-agámi, on the Kopamedza range, we proposed to build a survey station, and on the 24th the morning was fine, but when we reached the hill it had begun to cloud over for rain, and we had barely time to sketch a few points when everything was hidden in mist. It was particularly disappointing, as all we should have seen was new to us, and the way up had been so very bad, part of it through a newly felled forest where we had to climb and creep and play the tight-rope dancer over the fallen trees. Káken-agámi was too small to keep us supplied with rice, and bad weather promising, we had to move on, and on the 25th we marched to Nokami, and 26th to Imphema, having rain on both days.

The next morning Lieutenant Woodthorpe and myself made an excursion to Terocheswemi on the Kopamedza ridge, where we had a good view and added a good deal to our work. Halfway up we passed through Ketsáma where they treated us very civilly. So they did on our return, presenting each of us with a spear and rice beer, and offering to put us up if we would but stay, but after we had left the village and were passing below it, two spears were thrown from the jungle, from one of which a policeman had a very narrow escape; it shaved past the back of his neck. While enquiring about this and picking up the spears, some Nagas belonging to another village, who had come with us, told me that they had seen the men who threw them running away, and that they recognised them as belonging to another third village which was found afterwards to be untrue, for the men were truly Ketsáma men, as that village acknowledged next day, begging forgiveness and offering to turn the men out. These men were Angámies, all the other villages we had seen on this bank of the Doyong having been Sema, except Terocheswemi, which was half Angámi.

On the 28th, passing through Ungoma, the last of the Sema village in this direction, we encamped below Khesoma, and on the 29th, passing through Chájabamá on the Kopamedza range, camped at Rongazuma. I have called this range the Kopamedza, having no other name for it; it is the continuation of that range northward, and is the watershed between the Doyong and Laniere rivers. We halted at Rongazuma to the 5th February, clearing the hill Nummu, where we built a station. It fortunately cleared on the 5th, (having been raining the whole week previous), and though at one time it looked threatening and we had a sprinkle of snow, we finished our work, both sketching and triangulation, satisfactorily. The next day we encamped on the Siju below Sakábama, and on the 7th I went towards the trigonometrical station of Japoo, Lieutenant Woodthorpe having gone on the 6th towards Nidzokru.

The weather in Japoo was severe for my followers. Our camp was in the snow, which we found deeper and deeper the higher we went. We encamped at the last water and on the morning we tried the ascent and struggled on for three hours over a distance of about a mile, often waist deep in the soft snow, and when within two hundred yards of the summit found our way barred by an ice-covered precipice which was quite impracticable to laden men. Though in thin clothes and wet through, I felt that delicious tingling warmth that exercise in winter weather at home gives one, but my unfortunate carriers thought they were done for and talked of dying. As nothing could have been seen, clouds coming on, we gave it up, and slipping and tumbling hurried back to camp as quickly as we could, and reached it in less than a third of the time it had taken to go up. On the 10th I marched into Kohima, and on the 15th we started on our Laniere exploration.

Camping on the 15th on the Siju, on the 16th at Cháduma, and on the 17th at Tákubáma, we marched on the 18th to Razami, crossing the ridge and taking the Kopamedza station *en route*. It was a very heavy march, the snow, which I judge from the circumstance to be unusual on that range, having heaped the ground with boughs and creepers broken from the trees and beaten the bushes down so as quite to close the path in places and obliging us to cut our way through with knives and spear heads. On the 19th we marched to Thetchelumi, and 21st Kezabámi, (halting at each place a day), on the 23rd to Losemi, 24th Lozaphehome, and 25th Jessami, all Angámi Nága villages.

On starting on our next march we found the path thickly panjied almost to the camp; those who did it must have come within spear throwing distance of our sentries; they were known to be men from Primi, a village two marches to the north-east, by some seeds of a millet scattered in the way, with which grain they make their liquor in distinction from the other Nagas, who use rice. We encamped at Melomi, all the men of which place were drawn up in their high street to receive us, and not one of them with a stitch on below their waist. They do not, I should say, always go about quite so freely, on ordinary occasions probably wearing their clothes draped round them as do the Lushais, Tankhul Nágas and others who wear no waist cloth, but on this occasion their sheets were tied across their chests in the fashion in which all Nágas tie them when expecting fighting. The sight was very extraordinary certainly, and very much inclined one to cachination. On the 27th we marched on to Primi. It was men from this village who had obstructed our advance from Jessami. From the spur opposite their

village we saw them assembled to oppose us, but after some parley they broke up and we encamped unmolested. These men wear a small apron, and, like the Semas and Lotas, tattoo their breasts. On the 28th we encamped at Thetchunása, and on the 1st March at Thetchumi.

Here we found ourselves beyond interpretation. At the last village we had managed in a way by translation from Primi to Melomi, to Ángámi, to Assamese, to English, and *vice versâ*, to understand and express a little, but here signs were our only, fortunately we did not want much, and such signs as pointing to one's mouth and stomach are not easily misunderstood. Fortunately also we had no need to go further, as what we had especially come to see was before us. The map shows what we discovered—that the Lániere instead of flowing through the large valley to the north, as we thought, was met by a stream from that valley, and that both turning at right-angles escaped through the high ranges to the east, about fifteen miles south of the Sarameti peak. The height of the rivers near their junction we made out by barometer to be about 2,000 feet above sea-level. The conjoined rivers agree perfectly with a branch of the Kyendwen of the old maps.

From this point we began our return journey, not because there was nothing more to be done, or that we would not have gone on if we could, but we had no interpreter, and the people had no rice to give us; they lived themselves on (*jobs tears—coix lachryma*); so having accomplished one of the principal objects of the survey, we turned back. Dr. Brown, with his escort, and the Munipuris, left on the 2nd to march direct to Manipur. On the 3rd we started and camping again at Primi and Melomi, on the 5th and 6th we stayed at Kotisimi, 7th at Sowhemi, 8th at Kitsophemi, and 9th at Chipokitámi, all Ángámi villages, except Sowhemi, which was of naked Nagas and was built in the valley on the river bank, not on the hills as is the general custom. We were now returning by a more direct route than that we had come by, but had turned northward at Kitsophimi into a valley drained by a tributary of the Lániere, the Tizi, at the head of which we heard that there lived a tribe of Nágas in ten villages, all contrary to the democratic usage of the other Nágas, owning allegiance to one Chief. There were two paths, it was said, to these villages, but that on the west bank particularly bad; it must have been bad indeed, if it was worse than that we found on the other side; however, we at last reached the first of these villages called, as we afterwards learned from the name of its head man, Cherhi or Cherhena, and by the Ángámies, Mezamibásáma. It is the only one of the ten villages on the east bank. What followed I cannot account for, except on the supposition that expecting us to go by the west bank they had collected in force at the first village on that side, and that the jungle had hidden our movements, for, on coming up to the village, though some asked us to come up, others gave war cries. We reached the glacis, which was thick with panjies, and saw some two dozen men moving about inside, some seeming to wish to parley, others yelling, two unlucky spears, a stick and a feeble arrow flew over and then we fired upon them.

We found one—one of the headman's sons—dead when we got inside, a fine young fellow shot through the brain; what other casualties there were, if any, I do not know, but fourteen of our party stuck themselves with panjies, including Captain Butler and Lieutenant Ridgeway; their shoes were soaked with wading, and the sharp bamboo slips went through and through them. The only person otherwise wounded was my jemader of khalassies, who made himself too prominent and got a sharp crack on the shin from the stick.

On the hill, which opposite to us divided the two streams which form the Tizi, we saw a crowd of armed men, and prepared ourselves for an attack by occupying the upper end of the village, and pulling down the middle part, across which we threw a stockade. We supplied ourselves with rice from their granaries which our coolies husked and sifted. A careful watch was kept for two nights. On the third day peace was concluded, and Lieutenant Woodthorpe and myself crossed to Rehipumi, where we saw the blind Chief Rehipu who rules the clan,—a fine old man who must have had great strength when young. He had a curious manner of not raising his eyelids and often of not turning his head when speaking to or hearing any one speak, so I could not form an idea of how he lost his sight, probably by accident, not through age.

On the 13th we returned to Chipo-Kitámi, having decided that in our somewhat disabled state (five of the fourteen lamed had to be carried), it would be as well to leave further exploration of these unknown valleys and tribes till next year. On the 15th we marched to Ságájuma, where we halted one day, and after starting on the 18th had to return to give them a lesson.

They were a very strong village and used to lording it, having, I think I heard, sixteen other villages dependent on them. They would not give us coolies for our sick, and when we returned and occupied the village, both spears and shield were out, but it passed off and they were more obliging next day. From this we made four marches to Sámáguting, which we reached on the 22nd.

Leaving Sámáguting on the 26th and passing through the Terai (which is passable at this time of year) by Dimapur, Mohangdijua and Bokulia Ghât, I entered the hills again at Panimohur and reached Shillong *viâ* Jawai on the 7th of April. Lieutenant Woodthorpe, going by steamer from Nigriting to Gowhatty, arrived at Shillong on the 12th. Lieutenant Woodthorpe plane-tabled on the ½ inch scale about 1,150 square miles; Captain Badgley on

the $\frac{1}{4}$ inch scale about 2,250 square miles. They observed at three stations, the triangulation amounting to 800 square miles. It was an easy country to survey, and had not political reasons and the requirements of the large scale survey obliged us to halt and make short marches, more could have been done on the small scale.

The Naga Hills survey expedition this year was a most interesting one—not from any particular beauty of the country which, except in a few places, gave a tame view of long ridges unbroken by peaks and unenlivened by a single waterfall: nor from the climate—we had rain for a third of the time—but from the people, who, though they might generally be classed as vile, viler, vilest, were so new to us and so varied, one section from another, that one could not fail to be interested.

I will say nothing about the dress, &c., of the tribes, but add merely a few words with particular reference to one section of the tribes we visited. There is just one point, however, on which I would remark before doing so, which is, that I did not notice that any of the Nágas, either at Tesephima or Cherhe, the two places where they opposed us, wore "war-paint," some wore feathers, and some wooden tails ornamented with red and black hair, but I saw nothing approaching the custom of the American Indians, nor even so much color as is used by Hindoos. The only occasion on which we saw anything at all of the sort was at Lukámi. I think it was where the villagers had apparently been celebrating what might be called a "joom" burning festival (before the rains they burn the forest previously felled on land to be brought under cultivation; such fields are "jooms"), and some of them had their faces blackened with charcoal, and all were more than ordinarily dirty.

The frontier tribes I have seen appear divisible into three lots—Lushais, Kukies, Manipuris and Khásias,—Mikirs, Angámies, Tankuls, Semas and Rengmas,—Lotahs and naked Nagas. The first are light-skinned, short, with well-shaped broad heads, prominent foreheads, moderately thick lips, and moderately flat noses, wear all their hair (except the hindooized Manipuris), use (now discarding their spears for guns) a short chopping knife and a short thrusting spear or sword, and a small shield, cultivate by jooming. The second are light-skinned, tall, and the most handsome of the three, have well-shaped heads, often acquiline noses and thin lips, shave the head more or less, use no other weapons than the long spear and large shield, cultivate by terracing or jooming. The third are dark-skinned, short, have conically shaped heads, flat noses, thick lips, shave the head except a patch at the top, use the thrusting spear, an axe or heavy chopper, bows and arrows. The Lotahs use the same shaped shield as the second, but smaller, the others perhaps none (this is conjecture: we saw none among the naked Nagas.) The first and second are the stronger races; where the blood mixed in them with the Tartar comes from, I cannot say, and will only venture to hint at Malaya. They appear to be ousting the others for the special benefit of the country as regards the Angamies on account of their civilised method of cultivation. As regards the third, the resemblance to the Tartar races is much less marked; the people whom they most reminded me of (especially the naked Nagas, who are perhaps the least mixed in breed) are the Kols of Central India. Their dark skin, heads shaven except the tuft, the conical shape, their noses, and lips, the use of the axe and bow, their carelessness about clothing, all agree, and in no single instance did I see anything like the light skin, long face, acquiline nose, thin lips and pointed chin which is found among the better conditioned individuals of the Tartar tribes of the frontier.

Of the marriage ceremonies, modes of disposing of the dead and new born, and those many customs whose differences help the classification of races, I am grieved to say, that trusting that it would be done by others who had less to do than I, I have not learnt so much as to warrant my writing of them, even had not continued indisposition in this damp climate unfitted me for making an amusing report, and I beg you will excuse me if I finish off here with a few general remarks. As regards what every one could see of the general condition of the Nagas, they were well housed, clothed according to their wants, well fed and seemingly content, healthy, free from small-pox and skin diseases, deformities (except goitre among the Rengmas and Semas) and dwarfs.

From the facts that the hilly country stretches so far south from the Nága hills, and that the north is open to winds crossing the broad, damp valley of the Bramaputra, I should say that the summer rains are less and the winter rains more than in other parts of Assam. We had much rain during the season, and the weather was at times disagreeably raw and cold, perhaps exceptionally so. The recorded temperature was as follows:—

	Mean maximum.	Mean minimum.	Highest maximum.	Lowest minimum.
January	66°	44°	79°	37°
February	67°	44°	84°	36°
March	81°	49°	88°	42°

The minimum was observed daily, the maximum whenever opportunity offered. The heights of places of observation were between 3,000 and 6,000 feet, their differences seeming to have little effect on the temperature. On Jápvo, at about 9,500 feet, the minimum was 31, maximum 40 on the 8th and 9th February.

The rocks are sandstone and shale, which turns to a good slate in the hills to the eastward, where it is used for roofing. The summits of the ranges bounding the Laniere valley to the east are, I fancy, granite, one, an immense thimble-shaped rock so peculiar as to have a name, Kezatulazo, even among the Nagas on the Doyong, and some other points having very much the appearance of peaks of that stone. There is not much game in the country, I fancy; the population is too thick, and pot hunting too prevalent. On one of the few occasions on which I could leave the beaten track, I saw a couple of deer and fell into two artfully covered pit-falls, saving myself fortunately from going to the bottom, but hanging helplessly dangling up to my shoulders until dragged out each time. One can never have a good opinion of a people whose only idea of sport is in the use of such villainous contrivances, and who are so lurking and treacherous that any one of them would feel unsafe a mile from his village and would panji the road behind him on his return. On Japvo I saw some large apes tailless, of the size and appearance of apes from the Cape; they escaped by running, not by climbing the trees.

Extract from the Narrative Report of CAPTAIN GEORGE STRAHAN, R. E., *Deputy Superintendent in charge No. 7, or Rajputana Topographical Survey.*

Rajpootana.

The country through which my triangulation passed is uninteresting in the extreme; it consists for the most part of a plain diversified here and there with groups of sand-hills, some of them rising 80 or 100 feet above the general level. Rocky hills are so few and far between as to afford but little convenience for observing stations. Considerable difficulty was experienced in obtaining supplies, especially grass, and the water is brackish and only found at great depths. I measured one well over 400 feet deep. In many places several villages have to depend for their water supply on one well common to them all. Bajra appears to be the only crop grown. I was surprised to find that a system of telegraphy by the use of looking-glasses flashed in the sun was in use across this desert country from Ajmere to Bikaner. It is used by the opium merchants at the latter place. The system only supplies means for telegraphing whether the opium is selling at cheap, moderate, or high rates in Calcutta. Three places about 150 or 200 yards apart are selected at each telegraph station, and the person receiving the flash at the next station knows by observing at which of these three points the sender flashes, whether the rate is low, moderate, or high. The information is, of course, conveyed as far as Ajmere by electric telegraph. I saw the system in operation, but it did not appear to be very successful in consequence of the carelessness of the signallers whose duty it was to watch for the flash from the preceding station.

The general level of these plains appears to be about 900 feet above the sea. There is no appearance of rivers or watercourses of any kind, the small annual rainfall being almost immediately absorbed by the sand, which appears to be of immense depth. The sand hills do not shift their position to any great extent according to the statement of the inhabitants, and I hope that some of the principal stations which I had to build there at considerable expense may prove tolerably permanent. Marching over such a country is very fatiguing from the depth of the sand, and from its being extensively undermined by rats through the roof of whose burrows nearly every foot-step breaks. There are but few wild animals in this district, ravine deer, a very few nilgai and hyenas being all that I saw. The plane-tabling will no doubt make very rapid progress over such ground as this.

Description of the Ranpur Temple by MR. W. MCNAIR.

Ranpur temple is situated amongst a mass of hills of the Aravalli Range, in latitude 25°-6′-50″, longitude 73°-30′-49″ midway between the villages of Sadri and Bhanpur, with which it is connected by a road running parallel to a water-course for a mile and a half beyond the temple in a westerly direction as far as Malgarh, thence the road turns abruptly south and follows a ravine which takes its rise from the top of the hills 2,000 feet above Malgarh. A description of this pass is given by Captain Strahan in his Report on the Bhanpur Pass.

This temple derives its name from the ancient city of Ranpur, or Ranakpur, which existed during the fifteenth century, and is said to have contained a hundred thousand houses. Ruins are still visible in different directions round the temple even as far as Malgarh hill, on which stands the ruin of a fort supposed to have formed the western defence of the town.

The temple was built by Dhunna "Set" in the Hindoo year 1,496, corresponding to A. D. 1439, during the reign of Roma, son of Koja, who was descended from the famous Bapa. This hero was chosen by the Chiefs of Rajputana to lead their forces against Mahomed Kassim, the first Mahomedan invader of India. Kassim had in 714 conquered Sind, compelling the inhabitants to embrace the Moslem faith. After this he marched into Rajputana, but was met by Bapa and completely routed. Bapa on his return founded the Udepur monarchy, and from him the present Ranas claim their descent.

The temple buildings cover a rectangular piece of ground measuring 260 feet by 244 feet. It is enclosed by an outer wall having 86 cells, each of which contains an idol built against its internal face. In front of the cells and extending into the inner court is a verandah. In the centre of the inner court and parallel with the outer wall is a colonnade supporting a roof

and having at its four corners minarets, each of which contains an idol. This colonnade, or open verandah, surrounds an open space in the middle of the entire enclosure, in the centre of which is built the principal shrine. The pillars, 420 in number, which form the colonnades are richly sculptured with figures of Hindoo divinities. The principal idol, a drawing of which is given, is colossal, represented in a sitting posture, and is carved from a block of granite. Each of the 86 smaller idols is a model of it.

The temple is of sandstone, which must have been brought from the quarries of Narlai, 13 miles away. It stands on a raised foundation about 12 feet high. The view of the interior from the entrance porch is very magnificent and imposing. The long aisles and sculptured minarets lend an air of grandeur, which is heightened by the massive nature of the structure, and render probable the native statement that its construction cost 75 lakhs of rupees.

It is devoted to the Jain or Jaina system of worship, which is midway between Brahminism and Buddhism. Springing from the latter sect, it partakes more largely of its rites. They acknowledge the whole of the Hindoo gods, but consider their own saints or Jirthan Karas as superior to all, and to these they pay all worship and obedience. The Jirthan Karas are those hermits who by their ascetic practices have gained the heaven of both Jain and Buddhists, that is "Nirvana" or annihilation, a state of profound abstraction in which they are freed from all cares, sufferings, joys or sorrows. They pay great attention to the Vedas, the sacred Hindoo books, but, unlike the Brahmins, do not consider them sacred. They carry their regard for animal life to an absurd pitch, beyond even Buddhists. Their priests, or Jatis, dare not drink water at night lest they should swallow insects, and even in day light strain it through cloth before drinking; they carry a brush and before sitting, sweep the spot for fear of crushing any living thing. Their sacred language is Pali, closely allied to Sanskrit; they have a numerous literature and were the real refiners of the Tamil language.

This system originated about 600 A. D. and declined A. D. 1200. Jains still abound in Guzerat and Kanara; they are an opulent class, generally bankers. The Jain temples are generally very large and handsome, often flat roofed, with courts and colonnades but sometimes, like Hindoo temples, circular and surrounded by statues of Jirthankaras. Besides images they have marble altars, figures of saints in relief, and foot prints of holy men. The noblest specimens of Jain temples are the white marble remains on Mount Aboo; there are Jain caves at Ellora, Nassik and elsewhere. Near Chingraipatam in Mysore is an immense statue of a Jirthan Kara cut out of a rock and nearly sixty feet high. Their Jirthan Karas number 24 and are said to have lived fabulous ages; but the last and most celebrated who lived the age of an ordinary man was Parasnath, whose abode is on a hill of the same name in Bengal. The Jains, also called Sheawaks, are scattered about the West Coast and number probably 5,000,000. They were much persecuted in Madura in the extreme South, thus their leaders impaled and their race nearly rooted out about the eleventh century.

The temple is still considered of some importance. Pilgrims assemble from Guzerat, Bombay, Bhopal, and the North-West Provinces during the months of March and September, when a fair is held which lasts only for a day, owing to the bad reputation the pass has for murder and dacoities.

I was encamped within a few yards of the temple when the fair was held in March last.

For some days previous, travellers had come into Sadri, which is the nearest village on the Marwar side, and halted till the day of the fair. The Bheels on the contrary who have little or nothing to lose and are in fact the ones that commit, in company with the Menas, all the depredations in these passes, bring loads of bamboos the evening previous which are readily bought by the people of Marwar the following day.

From an early hour on this day till sunset the pass, which is about nine miles long, is strictly guarded by sepoys and sowars, sent by the Rajahs of Udepur and Jodhpur, as the pass runs through both States; on ordinary occasions the pass is considered open twice in the week, Sunday and Thursday, when all travellers are escorted through. On each side of the road for about 300 yards from the temple-steps temporary shops are set up merely by sticking into the ground a couple of bamboos six or eight feet apart with a sheet thrown over. The articles displayed consist principally of ornaments of the roughest workmanship, such as steel rings, earrings, noserings and bangles, also glass beads and looking glasses; these latter are much sought after. Some wooden toys are also shown, and, notwithstanding the exorbitant prices asked, are readily bought by the Bheel women and Banias' wives. Amongst the edibles, the dried pumpkin commands a large sale, and is taken into Marwar by the cart load, being a vegetable much sought after.

The pilgrims do their poojah first and spend the rest of the day bartering with the different shop-keepers. In the afternoon I went into the temple and was surprised at seeing, in front of the principal shrine, the pile of pice heaped up, amongst which glittered some silver coins. From enquiries made I was given to understand that yearly from six to eight thousand rupees are collected; half this sum is yearly spent in repairs and in supporting the guardians of the temple who live in the serai that adjoins the temple, the remainder is lodged in the hands of the daroga of Sadri. The number of pilgrims on this occasion exceeded ten thousands. The following is a translation of the inscription engraved on the wall of the central shrine;

In the year 1496 of the Samvat era, amongst the Meywar Rajahs are (1st) Bapa, (2nd) Goil Rajah, (3rd) Bhogsel, (4th) Kalbhoj, (5th) Bhartari Bhut, (6th) Maik, (7th) Sing, (8th) Khoomar Raja, who bestowed much alms, (9th) Mandlat, (10) Narban, (11th) Sakti Koomar, (12th) Sochi Baran, (13th) Kirthi Baran, (14th) Jog Raj, (15th) Bairatthi, (16th) Bansipal, (17th) Harri Sing, (18th) Bersing (19th) Arra Sing, (20th) Chorsing, (21st) Bikram Sing, (22nd) Arrising, (23rd) Khemsing, (24th) Samat Sing, (25th) Komar Sing, (26th) Mathan Sing, (27th) Punna Sing, (28th) Chez Sing, (29th) Tej Sing, (30th) Samar Sing, who had no sons, (31st) Chun Sing, (32nd) Fee Sing, (33rd) Begmag Sing, (34th) Ajjee Sing, his brothers Arre Sing, Sunier Sing, Hammat Sing, Lakshaora Sing, Mokal Sing, who bestowed much in charity. Khoja Rana laid out several gardens and built many houses; he conquered the land of Nagpur from king Narain Mandal Puri, as well as fought against several powerful Rajahs and destroyed his enemies.

In the reign of Romar Rana, Dharma Set was born; he made many pilgrimages and repaired dilapidated dwellings; his elder brother's name was Rathna, who had four sons, Lakha, Sajha, Sona and Salaj; these were by his chief wife; by his second wife he had Jhaja, Jhawar and Bardman. This Dhunna "Set" built three "Loks" in Ranpurnagar, also four of the temple doors, and gave his name to them, his grandson invited a Gúrú, and with the assistance of Sripugjuggat Chander Suri and Dewant Suri (the Gúrús adopted children) and several pilgrims performed their purifications here in the Hindoo year 1496.

COMPILING, DRAWING AND GEOGRAPHICAL EXAMINING BRANCH, SURVEYOR GENERAL'S OFFICE.

Statement showing the nature of the work performed, and the progress made from 1st January to 31st December 1874.

Maps, &c.	Scale. Miles. Inches.	Progress and Remarks.
India—Standard in 6 sheets ...	32=1	New materials from the several surveys in progress inserted, waiting further survey.
India—No. 3, reduced from above standard, 4 sheets ...	64=1	Engraving; fresh additions made on dry proofs from recent surveys, Sumatra compiled and new names written.
India—for a general map of the world	10=1	Sheet 7, between parallels 25° and 30° and meridians 74° and 78°; sheet 19 between parallels 20° and 25°, and meridians 90° and 94°, suspended.
India—6 sheets	32=1	A reproduction of the standard map divided into 6 uniform sheets, blue prints taken to be re drawn with a view to speedy publication, sheets 1 and 5 out-lined, sheet 4 (Bengal) out-lined and written, nearly completed.
Bengal—Standard in 4 sheets ...	16=1	Proofs examined and corrected. Original sheets brought up to date from recent surveys.
Bengal—Eastern Frontier of 3 sheets	4=1	Originals being completed from recent surveys to date. In progress.
Bengal—Western, in 10 sheets ...	8=1	The following sheets compiled and drawn complete with hills. Sheet 14, Midnapore, Balasore, Singhbhoom, and part of the Orissa Tributary States. Sheet 15, Cuttack and Pooree Districts. Sheet 13, parts of Hazareebagh, Manbhoom, Lohardugga, Sonthal Pergunnahs, and Beerbhoom. Sheet 11, part of Nepal. Sheet 17, parts of Sarun and Shahabad. Sheet 18 } Part of Lohardugga and the Gurjat Sheet 19 } States of Chang Bhokar, Korea, Sirguja, Oodeypore, Jashpore, Gangpore and Bonai. Sheet 20, part of the Orissa Tributary States. These sheets complete the series.
Oudh—Outline map ...	16=1	Fresh additions made on dry proofs and all necessary names written; engraving.
Sindh—The Province of ...	16=1	Compiled and drawn complete with hills, &c.; engraving.
Assam—In 8 sheets, Provinces under the Chief Commissioner ...	8=1	Compilation of sheets 4 and 5 embracing parts of Goalpara, Kamrup, Nowgong, the Garo, Khasia, Jaintyah and Naga Hills, with Sylhet, in progress from latest surveys.
Assam—Northern Frontier of ...	8=1	Compiled and drawn from the latest surveys and the best materials for use of the Duffla Expedition.
Bhootan—New Map of ...	8=1	Compiled and drawn from the best available information with hills.
Punjab—Outline Map ...	32=1	Fresh additions compiled of countries on north-west frontier, for a new edition.
DIVISIONAL MAPS.		
Dacca Division	16=1	Drawn for the "Imperial Gazetteer" of Bengal.
Cooch Behar Division } Patna Division ... }	8=1	Skeleton maps on vellum cloth to illustrate the famine relief operations, &c.
Bengal and Behar	64=1	2 copies } To shew extent of jute cultivation and
Do.	32=1	2 copies } manufacture.
DISTRICT MAPS.		
Lohardugga ... } Shahabad ... } Monghyr ... ... }	4=1	Tracings on vellum cloth for reproduction, prepared in skeleton form to illustrate the famine relief operations and other projects.

Statement showing the nature of the work performed and the progress made from 1st January to 31st December 1874—continued.

Maps, &c.	Scale.	Progress and Remarks.
DISTRICT MAPS—*continued.*		
Bhaugulpoor ...		
Purneah ...		
Midnapoor ...		
Burdwan ...		
Julpaigoree ...		
Sontiah Purgunnas ...		
Chumparun ...	4 – 1	Tracings on vellum cloth for reproduction, prepared in skeleton form to illustrate the famine relief operations and other projects.
Sarun		
Tirhoot		
Bancoorah ...		
Singhbhoom ...		
Rajshahi ...		
Gaya		
Cooch Behar ...		Compiled from Revenue Survey sheets.
Chindwara District	4=1	Reduced from the Revenue Survey sheets and drawn complete with hills.
Hazara District	4=1	Ditto ditto ditto.
Hazara, vernacular map ...	4=1	Drawn for use of the native officials under the Deputy Commissioner of Hazara by special request, in outline.
Darjeeling District	4=1	Reduced from sheets of the Revenue Survey, drawn complete with hills and the Native State of Sikkim also added from best available sources.
Garo Hills District	2=1	Compiled and drawn complete with hills from the latest Topographical Survey.
Nowgong District	4=1	Reduced from sheets of the Revenue Survey, outlines in progress.
Baitool District ...	4=1	Reduced from sheets of the Revenue Survey, outlines in progress.
Sibsagar District ...		
Lakhimpur District ...		
Raipur District ...		
Karauli Native State ...	4=1	Drawn for the Rajputana Gazetteer.

Sheets of the Atlas of India, engraving in India.

Maps, &c.	Progress and Remarks.
Sheet 34, quarters, N. W. and S. W.	Parts of Jeypur, Udeypoor and Bundi Native States and Ajmere, additional material to date from recent surveys compiled and drawn in outline. In progress.
„ 49, full plate	Rajputana State Railway inserted on a dry proof.
„ 52, N. W., N. E., S. W., S. E.	Parts of Malwa and Gwalior, Tonk and Jhalra Patan Native States, N. E. and S. E., compiled and drawn with hills, N. W. and S. W. in progress.
„ 53, quarter, N. E. ...	Part of Bhopal compiled and drawn to date in outline. In progress.
„ 67, full plate	Part of Oudh compiled and drawn to complete plate.
„ 72, quarter, N. W. ...	Part of Chindwarra District compiled and drawn in outline. In progress.
„ 93 „ N. E., S. W. ...	Parts of Jeypore, Bustar and Godavery Talooks (Vizagapatam Agency), N. E., hills, drawn on a dry proof; S. W., additions made to date in outline. In progress.
„ 105 „ S. W. ...	Parts of Belaspur and Sumbulpur Districts and Gurjat States, Chota Nagpur Division, compiled and drawn in outline. In progress.
„ 106, full plate	A dry print proof of this plate, under correction on the north-west for the Native State of Raigarh from the sheets of the Chota Nagpore Division Survey.
„ 107, and 108 full plates ...	Jeypoor, Kalahandy, Panchpetta, &c., of the Vizagapatam Agency, hills drawn, to complete.
„ 113, full plate	Hazarebagh compiled and drawn in outline on a dry proof to complete plate. In progress.

Sheets of the Atlas of India, engraving in India—continued.

Maps, &c.	Progress and Remarks.
Sheet 115 and 116, full plates ...	Orissa new canals and roads, inserted on dry proofs to bring up to date.
„ 119, full plate	Part of the Garo Hills, compiled and drawn in outline from recent surveys to complete plate. In progress.
„ 124, quarters, N.E., S. E., S. W.	Parts of Goalpara, Kamroop, Durrung and Nowgong, additions of new material to complete plates under compilation. In progress.
„ 125, quarters, N.E., S. E., N. W.	Parts of the Garo, Khasia, and Jaintiah Hills, additions to complete plates compiled and drawn in outline. In progress.
„ 130, quarter, S. W. ...	Part of the Naga Hills, additions from recent surveys under compilation. In progress.
„ 131, quarter, N. W., S. W. ...	Part of the Naga Hills and Manipur, additions from recent surveys under compilation. In progress.

Sheets of the Atlas of India, engraving in England.

Sheet 8, quarter S. E. ...	Part of Sindh, proof corrected and returned to England.
„ 50, full plate	Parts of Jeypore, Ulwar, &c., proof corrected, completed with hills, &c., and returned to England.
„ 69, quarter S. E.	Part of Bundelkund, proof corrected and returned to England.
„ 70 „ N. E.	Part of Bundelkund, proof corrected and returned to England.
„ 71 „ N. W., S. W. ...	Parts of Bhopal, Hoshungabad, Chindwara, &c., Chindwara portion compiled and drawn complete with hills, proofs corrected and returned to England.
„ 89, full plate	Part of Rewah, &c., proof corrected, additions made and returned to England.
„ 90, quarter N.E., S.E. and N.W.	Parts of Belaspur District, Rewah and Gurjat States of Chota-Nagpur Division, S. E., proof corrected, N. W., compiled and drawn with hills to date and sent to England, S. E., additions to complete this plate under compilation, N. E., drawn in outline only.
„ 91 „ N. E., S. E. ...	Parts of Belaspur and Raipur, additions to complete plates and under compilation. In progress, nearly ready.
„ 92 „ S. E.	Parts of Jeypur and Bustar, proof corrected and returned to England.
„ 104, full plate	Parts of Hazaribagh, Lohardaga, &c., proof corrected and returned to England and hills drawn complete.
„ 105, quarter N. W. ...	Part of Gurjat States of Chota Nagpore Division, proof corrected and returned to England.
„ 118, full plate	Part of Bhootan and the Western Dooars, proof corrected and returned complete to England with additional hills drawn.
„ 126, quarters N.W., N.E., S.W., S.E.	Eastern Districts of Bengal with Hill Tipperah and Lushai Hills, &c., proofs corrected, additions compiled, and drawn complete with hills and returned to England.
„ 127 „ N.W., S.W., N.E., S.E.	Eastern Districts of Bengal, proofs corrected, additions compiled and drawn complete with hills and returned to England.
„ 128 „ N. E.	Part of Chittagong and Akyab, dry proof corrected and returned to England.

Standard sheets of the Topographical Survey, re-drawn for Photozincography.

Maps &c.	Scale.	Progress and Remarks.
Chota Nagpore Division Survey.		
Sheets, 9, 10, 11, 12, 13, 14, 16, 21, 22 & 23	1=1	Projected and re-drawn from the original field sections.
Sheets 5, 15, 17, 20 and 2 ...	1=1	Projected and in progress in various stages.
Ganjam and Orissa Survey.		
Sheets, old series, 9, 49, 59, 70 and 72.	1=1	Projected and re-drawn from the original field sections.
„ 12, 13, 14, 15 and 15A. ...	2=1	Ditto ditto ditto.

Standard Sheets of the Topographical Survey re-drawn for Photozincography—continued.

Maps, &c.	Scale.	Progress and Remarks.
Ganjam and Orissa Survey—conld.		
Sheet 7, 11, 20, 21, 38, 47, 49, 60, 61 85 and 87	1=1	Projected and in progress in various stages.
„ 26, 27, 28 and 29 ...	2=1	Ditto ditto ditto.
North-East Division Central Provinces Sheet 11	1=1	Projected and re-drawn.
Miscellaneous Maps, &c.		
India Sketch Map	32=1	Showing financial circles and Customs line to 1874, prepared for the Financial Department.
Hill Tipperah	12=1	

Index to the Atlas of India. A new one prepared for general use.

„ to the surveys of India, to accompany Surveyor General's Report for 1873-74.

„ to the one inch sheets of the survey of India, 32 miles=1 inch, 3 copies.

„ Garo and Khasia Hills Survey, 16 miles=1 inch, prepared on vellum cloth for reduction to half scale, by photography.

Corrections and additions to Topographical Survey sheets, 1 mile=1 inch, and 2 miles=1 inch; 51 sheets examined and corrected.

Corrections and additions to engraved, lithographed and photozincographed maps, various { railways, boundaries, territorial names heading, and footnotes and titles, &c., inserted, examined and corrected in 2,120 sheets.

Lithographed and photozincographed maps and plans colored 18,590 sheets.

Atlas sheets and engraved maps colored 5,902 „

Proofs examined of Atlas sheets, maps, charts and plans 1,162 „

Surveyor General's Office, Calcutta,
1st *January* 1875.

J. O. N. JAMES,
Assistant Surveyor General.

ENGRAVING BRANCH, 1874.

Annual Progress Report, Engraving Branch, Surveyor General's Office.

No. of Atlas sheets.	*Atlas Sheets finished and ready for publication.*	When finished.
2 S. E.	Completed and ready for publication.	August.
9 N. W.	Ditto ditto ditto.	April.
9 N. E.	Ditto as far as drawing on survey is done, about three-fourths of the sheet still blank.	October.
53 S. W.	Ditto as far as drawing or survey is done.	December.
72 S. E.	Ditto ditto ditto. A very small portion remains blank in the N. W. corner.	Ditto.
124 S. E.	Ditto as far as drawing ditto.	July.
131 N. W.	Ditto ditto ditto.	October.
7 Plates.		
	Sheets of the Indian Atlas that have been in hand for additions, repairs and alterations.	
Double Elephant or full-size plates.		
17	Additions, finished.	
26	Hill work, repaired.	
29	Additions, finished.	
30	Ditto and corrections, finished.	
31	Ditto ditto ditto.	
42	Hills repaired, ditto.	
44	Additions, ditto.	
47	Ditto ditto.	
48	Ditto ditto.	
49	Ditto Railways, ditto.	
57	Ditto ditto.	
62	Ditto ditto.	
63	Ditto Border recut, ditto.	
64	Ditto ditto.	
74	Ditto ditto.	
75	Writing recut, ditto.	
76	Additions, ditto.	
77	Ditto ditto.	
78	Hills repaired, ditto.	
106	Writing recut, ditto.	
113	Writing recut, ditto.	
114	Additions, ditto.	
121	Ditto.	
	Quarter Sheets.	
1 S. E.	Additions, finished.	
2 S. W.	Ditto ditto.	
3 N. E.	Ditto ditto.	
3 S. E.	Ditto ditto.	
51 N. E.	Ditto ditto.	
51 S. E.	Ditto ditto.	
51 S. W.	Ditto ditto.	
87 N. W.	Ditto ditto.	
87 S. W.	Ditto ditto.	
105 N. E.	Ditto ditto.	
125 N. E.	Ditto ditto.	
34 Plates.		
	Miscellaneous maps and other work finished, and additions and corrections made.	
1	Map of Oudh, scale 16 miles = 1 inch.	
2	Small map of Bengal.	
3	Ditto Burdwan Division.	
4	Ditto Presidency ditto.	
5	Ditto Dacca ditto.	
6	Map of the Punjab, additions.	
7	Ditto North-West Quadrilateral, additions.	
8	Index Chart to the G. T. Survey of India, additions.	

No. of Atlas sheets.		When finished.
	Miscellaneous maps and other work finished, and additions and corrections made,—Continued.	
9	Map of India, No. 1, additions.	
10	Ditto No. 2, ditto.	
11	Plate of instruments used in the G. T. Survey.	New plate.
12	Theodolite plate 4, additions.	
13	Ditto ditto 5 ditto.	
14	Signal apparatus plate 10, additions.	
15	Topographical items ditto.	
16	Plan and section illustrative of the towers.	New plate.
17	Colonel Everest's plan of towers, additions.	
18	New plate of imprints with month and date.	
19	Map Heading for Revenue Survey.	
5	Five scales engraved for the M. I. D.	
Plates 24	*Atlas sheets in hand up to December* 1874.	
2 N. E.	Outline and writing done, hills in progress.	
34 S. E.	Ditto ditto ditto.	
52 S. E.	Ditto done, writing in progress.	
52 N. E.	Ditto ditto done, hills in progress.	
53 N. E.	Ditto ditto ditto.	
D. E. 55	Writing being re-cut.	
„ 58	Repairing hills.	
„ 59	Writing being re-cut.	
„ 60	Hill work being re-etched.	
„ 61	Writing being re-cut.	
„ 67	Outline of new survey done, writing in progress.	
72 N. W.	Outline done, writing in progress.	
72 N. E.	Outline and writing done, hills in progress.	
D. E. 73	Additions and corrections in progress.	
„ 75	Writing being re-cut.	
„ 88	New survey, heavy sheet, writing in progress.	
93 N. E.	Outline and writing done, hills just commenced.	
93 S. W.	Ditto done as far as drawing, writing in progress.	
93 S. E.	Ditto ditto ditto.	
D. E. 103	Writing being re-cut.	
105 S. W.	Outline done, writing just commenced.	
D. E. 107	Additions done, hills in progress.	
„ 108	Ditto outline done, writing just commenced.	
„ 111	Writing being re-cut.	
„ 112	Ditto ditto.	
„ 113	Large portion being cleaned off the plate for new survey.	
„ 119	Outline of new survey done, writing just commenced.	
„ 124 S. W.	Ditto done, writing in progress.	
„ 125 N. W.	New survey outline and writing done, hills in progress.	
33 Plates of Atlas sheets in hand.	Engraving the borders of four quarter sheets, and two projected *viz :* Atlas sheets 130 S. E. and 130 S. W.	
	Miscellaneous maps and other plates in hand up to December 1874.	
1	No. 3 Map of India in four sheets, outline done and writing well advanced.	
2	Map of Sindh, just commenced.	
3	Plan of Calcutta, additions nearly done.	
4	Large Tint being ruled.	
5	New imprints nearly done.	
6	Old ditto alterations in progress.	
6 plates in hand.		

Copper-plate printing branch, number of impressions taken.

Transfers	... ..	662
Proofs	... ...	1,206
Impressions	... ...	10,529
	Total ...	12,397

12,397 Impressions of transfers, Atlas sheets and other maps likewise of miscellaneous work.

104 Plates have been in progress during the year 1874.

SURVEYOR GENERAL'S OFFICE, CALCUTTA,
1st *January* 1875.

J. O. N. JAMES,
Assistant Surveyor General.

APPENDIX D.

Dr. *Abstract Cash Accounts from 1st January to 31st December 1874* *Cr.*

Items.	Amount.			Total amount.		
TO MAP SALE ACCOUNT.	Rs.	A.	P.	Rs.	A.	P.
Amount received from sundries	849	2	6			
Sales by Punjab Printing Company	395	0	0			
„ by Curator of Government Books, N. W. Provinces ...	218	8	4			
„ by Thacker, Spink and Co.	3,132	10	6			
„ by Curator of Government Books, C. Provinces	16	0	0			
„ by Mrs. E. Williams	412	0	0			
„ by Superintending Engineer, Bombay	17	8	0			
				5,039	13	4
TO REFUND ACCOUNT.						
Amount received from Mr. J. H. O'Brien, Probationary Assistant Surveyor, in part refund of his pay and allowances for not having served three years as stated in agreement signed by him at the time of admission.	285	0	0	285	0	0
TOTAL ...	...	...	...	5,324	13	4

Items.	Amount.			Total amount.		
BY TRANSFER ACCOUNT.	Rs.	A.	P.	Rs.	A	P.
Amount paid to Bank of Bengal, No. 59, dated 7th January 1874 ...	407	4	0			
Ditto ditto No. 201, dated 2nd February 1874, and No. 383, dated 20th February 1874. ...	442	8	0			
Ditto ditto No. 625, dated 30th March 1874 ...	236	0	4			
Ditto ditto No. 640, dated 1st April 1874, and No. 854, dated 30th April 1874	3,172	10	6			
Ditto ditto No. 1040, dated 28th May 1874 ...	17	8	0			
Ditto ditto No. 1178, dated 29th June 1874 ...	16	0	0			
Ditto ditto No. 1494, dated 15th August 1874 ...	285	0	0			
Ditto ditto No. 1648, dated 23rd September 1874, and No. 1674, dated 28th September 1874.	429	0	0			
Ditto ditto No. 1724, dated 8th October 1874 ...	193	12	0			
Ditto ditto No. 1994, dated 27th November 1874 ...	14	4	0			
Ditto ditto No. 2251, dated 30th December 1874 ...	93	6	6			
Ditto credited to Government of Bombay, as per Superintending Engineer, Bombay, No. 1182, dated 29th May 1874.	17	8	0			
				5,324	13	4
TOTAL ...	...	...	...	5,324	13	4

H. L. THUILLIER, *Colonel,*
Surveyor General of India.

Memorandum showing the total amount recoverable from the Map Sale Agents for 1874.

Punjab Printing Company	Rs	168	4 0
Curator of Government Books, North-Western Provinces ...	„	114	0 0
Messrs. Thacker, Spink & Co.	„	3,230	1 0
Messrs. Thacker, Vining & Co., Bombay	„	200	7 0
Curator of Government Book Depot, Central Provinces ...	Rs.	320	8 0
Messrs. Cotton and Morris, Simla	„	50	14 0
TOTAL	Rs.	4,084	2 0

Report by CAPTAIN J. WATERHOUSE, *Assistant Surveyor General, in charge Photographic Branch, dated the 1st January* 1875.

1. AMOUNT OF WORK.—The amount of work performed between the 1st January and the 31st December may be briefly stated as follows:—

1,280 original maps and other subjects have been received, 812 transfers have been made to zinc or stone, 1,53,242 complete photozincographed copies of maps, &c., struck off, besides 1,324 silver prints, and 1,495 photocollotypes.

2. PROGRESS.—The difference between the amount of work turned out in the year under notice and in the previous year is shown in the table below, from which it will be seen that, although the number of original maps received is less than in the previous year and the numbers of negatives and transfers are only very slightly less, there has been an enormous increase in the out-turn of printed sheets, estimated both by the number of pulls, or actual work done, and by the number of complete copies. This is attributable to the large demand for maps of the districts invaded by famine in the early part of the year, and to meet this demand, an extra press was set up and the ordinary establishment made to work extra time, the result being that between the months of January and July upwards of 27,800 sheets of famine maps were struck off in this office alone, of which number, 12,400 were done in the month of March. The number of silver prints is less than last year, but this process is now comparatively unimportant and but little used.

3. The photocollotype work has not progressed so satisfactorily as I could have wished, but this may be accounted for partly by a change in the establishment working this process and a consequent loss of time in learning the details as modified for use in this country, and partly by the great difficulties and uncertainties met with in working the gelatine films in this unfavorable climate:

SUBJECTS.	1873.	1874.	Difference.	Difference in decimal square feet.
Originals	1,611	1,280	— 331	
Negatives	1,969 *5110·72 d. s. f.**	1,933 *5203·36 d. s. f.**	— 36	*+9,264 d. s. f.**
Silver prints	2,010 *3553·84 d. s. f.*	1,324 *1610·06 d. s. f.*	— 686	*—194,378 d. s. f*
Phototransfer prints ...	1,949 *5157·88 d. s. f.*	1,926 *5276·21 d. s. f.*	— 23	*+118·33 d. s. f.*
Photocollotypes	3,000	1,495 *2668·55 d. s. f.*	— 1,505	
Transfers to zinc	829	812	— 17	
Number of pulls	1,1.1876	1,57,600	+ 45,724	
Ditto of complete copies ...	1,05,753	1,53,242	+ 47,489	

* Decimal square feet of 100 square inches.

4. EXPENSES OF WORKING.—The approximate expense of working the office during the year, including the Superintendent's salary, has been Rs. 61,176-14-1.

5. The approximate sum to credit of the department is Rs. 87,826-11-6, showing a nominal profit of Rs. 26,649-13-5.

6. PERSONNEL.—I have much pleasure in reporting on the continued good conduct and steady attention to their duties of my European Assistants, Messrs. J. Mackenzie, B. Mackenzie, J. Watson, and Sergeant Harrold. Corporal Marshall, R. E., arrived from Chatham on the 20th March, and took charge of the collotype printing; and though he has not made the progress that was expected from his training in England has worked very hard to adapt the English methods for use in this climate and has produced some very fair results, and it is hoped that with further experience he will do better.

Syud Ishmael and the other Native assistants have also worked satisfactorily.

7. PROCESSES.—There have been no changes of importance in any of the processes used. A method of preparing the phototransfers by Captain Abney's papyrotype process was tried, but was not successful for want of the proper transfer paper and appliances. A supply of paper has just been received from England, and the experiments will be resumed immediately.

8. By this process the phototransfers are prepared by inking in a print on paper prepared with gelatine, chrome alum and bichromate of potash, and on which the gelatine being consequently insoluble serves both as a protection for the fine lines and to prevent the transfer print slipping and the ink spreading during the process of transfer to zinc, thus the work is sharper and the fine lines are better preserved than in the ordinary process, where the superfluous ink is washed away with the unaltered gelatine and the fine lines are liable to be lost.

9. Photocollotype Process.—On the arrival of Corporal Marshall a great many experiments were tried to work the collotype process in the manner practised successfully by Captain Abney at Chatham, but it was found that these methods could not be used with advantage in this climate, and after several trials the following formula was adopted as giving the best results :—

Gelatine	...	...	...	...	1½ ounce.
Glycerine	...	...	...	...	1½ dram.
Albumen	...	...	...	...	1 ounce.
Bichromate of potash		...	...	...	40 grains.
Chrome alum	...	...	...	...	7 grains.
Water	...	...	...	...	12 ounces.

In other respects the working of the process is much the same as described in previous reports. The principal work done by this process during the year has been a series of plates of illustrations of the sculptures in the caves of Cuttack reproduced direct from the casts made by Mr. H. H. Locke for Babu Rajendralala Mitra's work on the antiquities of Orissa. The series, though not so perfect as could be wished, admirably show the superiority of the process and its immense superiority over lithography for such work.

10. Experimental Work.—Much of the limited spare time the charge of two offices leaves me available during the year has been devoted to drawing out plans of the new buildings for the Survey offices, and in preparations for the transit of Venus, and consequently I have not been able to do all I should have liked in advancing the special work of the office. I have continued my observations on the solubility of chrome gelatine tissues and on the effect of the addition of organic acids to a mixture of gelatine and bichromate of potash in connection with the collotype and the ordinary phototransfer processes, and it is probable that when I find leisure to go more closely into the subject, that useful results may be obtained. Several foreign systems of collotype printing have been experimented upon, particularly those in which the sensitive surface is spread over *metal* plates, and which would possess many advantages over the usual methods with glass plates, but the pressure of current work and constant interruptions caused by other demands upon my time and attention render it difficult to carry such experiments to a practically successful issue.

11. The Transit of Venus.—Though this great event of the year does not come within the scope of the ordinary work of the Department, this office has taken an important part in the observations of it by means of photography. In August I was appointed to the charge of the photographic observations under Colonel Tennant, and from that time till the beginning of October, when I left Calcutta to join Colonel Tennant, at Roorkee, the whole of my spare time was taken up in experimenting on various dry processes with a view to find one suitable for use for taking the solar photographs with the photoheliograph. A summary of the results of these experiments and a full account of the operations are given in the accompanying memorandum, and it will be sufficient to say that 107 photographs on 6-inch plates were taken at intervals of two minutes during the progress of the transit, besides five circular plates of the three last contacts and two intersections taken in the Janssen apparatus. Each of these circular plates comprises 60 separate pictures taken at intervals of about 1·21 minutes.

12. Thirty-nine photographs of transit were also taken in Calcutta, under the superintendence of Mr. J. O. N. James, Assistant Surveyor General, with a rough photoheliograph I had made up for the dry plate trials. These photographs, though smaller and not so perfect as the ones taken with the finer instrument at Roorkee, and of no strictly scientific value, may be useful as a complete series showing the phases of the whole transit, and for comparison with others taken in different places.

13. Hand-book of Topographical Drawing for India.—The want of good specimens of writing, printing and topographical drawing suitable for the maps of the Indian surveys under the new system of drawing in pen and ink for reproduction by photography has long been felt, and I have therefore endeavoured to supply the want by collecting a series of the most suitable alphabets either hand-drawn, engraved, or from ordinary type and specimens of drawing selected from maps of the Revenue and Topographical Surveys that were considered to be most suitable in style and execution for successful reproduction by photozincography. The earlier publication of this collection was delayed by the demands of current work on the presses, but the first part containing the specimens of cartographic writing and printing has been issued, and the plates of the second part containing specimens of drawing will be proceeded with immediately so that it may be ready before the end of the year.

Abstract of work performed in the Photographic Branch of the Surveyor General's Office from 1st January to 31st December 1874.

Maps photographed.	Number of sections or sheets.	Number of negatives or plates.	Prints.			Transfers to zinc or stone.	Number of pulls.	Number of complete copies.	Remarks.
			Collotypes.	Silver	Transfer.				
Topographical Maps ...	140	223	...	222	204	...	21,565	21,760	
Revenue Survey Maps	689	1,003	...	16	1,057	...	46,676	39,908	11,995 Anastatic.
District Maps ...	25	84	...	...	93	...	14,810	10,470	470 ditto.
General „ ...	23	97	...	32	111	...	8,930	5,874	
City and Cantonment Plans	69	80	...	...	83	...	14,418	5,040	
Miscellaneous Maps ...	334	446	1,495	1,054	378	...	50,070	70,190	2,240 Anastatic. 346 Zincograph.
Zincographic and Anastatic Transfers ...	...	...	...	...	...	812	...	...	
Proofs	...	...	...	...	...	...	1,131	...	
Total ...	1,280	1,933	1,495	1,324	1,926	812	1,57,600	1,53,242	

Statement showing cost of working the Photographic Branch of the Surveyor General's Office from 1st January to 31st December 1874.

Dr.	Number of complete copies.	Rs.	A.	P.	Dr.	Rs.	A.	P.
Topographical Survey Maps	21,760	21,237	14	7	Superintendent's salary from 1st January to 31st December 1874.	10,809	4	6
Revenue Survey Maps ...	27,913	34,455	8	4				
District Maps ...	10,000	6,479	15	2	Sanctioned establishments and house-rent from 1st January to 31st December 1874.	24,382	1	9
General „	5,874	5,400	3	4				
City and Cantonment Plans	5,040	8,205	0	0	Contingencies, inclusive of chemicals received from the Government Medical Store Department on emergent indents, and stores from England (as far as invoices have been received)	12,327	4	11
Miscellaneous Maps ...	67,594	2,667	7	9				
Anastatic „ ...	14,715	7,242	6	0				
Zincographed „ ...	346	11	1	0				
Silver prints	1,324	1,145	13	4	Cost of paper	13,656	2	11
Photocollotype ...	1,495	981	6	0	Balance in favor of the Department	26,649	13	5
Total ...	1,56,061	87,826	11	6	Total ...	87,826	11	6

J. WATERHOUSE, *Captain,*
Asst. Surveyor General,
In charge Photographic Branch,

Calcutta, 1st January 1875.

Memorandum on the Photographic Operations connected with the Observation of the Transit of Venus at Roorkee, December 8th (9th Civil) 1874.

Personnel.

The operations were under the charge of Captain J. Waterhouse, Assistant Surveyor General, assisted by Sergeant J. Harrold, R. E., a photographer from the Surveyor General's Office, Calcutta; and Lance-Corporal George and Private Fox of Her Majesty's 55th Regiment, who had been trained in the ordinary photographic manipulations by Colonel Tennant. Three native khalassies were also entertained for cleaning the rooms and apparatus and other miscellaneous duties.

Equipment.

The instrument used on this occasion for taking the solar photographs was an equatorial photoheliograph by Dallmeyer, exactly similar to those furnished to the English observing parties, and therefore requiring no special description. The necessary equipment of chemicals and apparatus was supplied partly by the stores sent specially from England, and also in great part from the Surveyor General's Office, Photographic Branch, and my own private apparatus; for the wet-plate chemicals, supplied from England in the first instance, were lost on the voyage, and the second supply came too late. The other chemicals and appliances sent from home were principally meant for dry-plate work, but, as will be seen, this process was abandoned. A great many appliances, such as shelves, extra plate boxes, a drying box for dry-plates, plate-racks, &c., &c., had to be made up on the spot at the Canal Foundry, the Sapper and Miner Workshops, and by native carpenters under my own immediate supervision.

General arrangement.

The general arrangement of the Photographic rooms in the Observatory was very convenient and efficient. As will be seen from the accompanying plan, the dark-room was about 10′ × 10′ and was entered by a double door leading out of the general entrance to the Observatory. On the right hand, in front of the window, was the developing table with an ample supply of water at hand contained in two tanks, one inside and the other outside the room. On a shelf close by were placed all the chemicals used in developing. On the left was a table for the sensitising baths, and shelves conveniently placed for the collodion and plate boxes. Directly in front of the entrance-door a second set of double doors, with a passage between them, opened into the Instrument room, in which was the Photoheliograph. In order to obviate the necessity for constantly opening these doors for the passage of the dark-slides to and fro during the operations, a box opening at both ends and large enough to hold a dark-slide was let into the panelling of each of the doors, and in this manner the dark-slides were passed backwards and forwards between the dark-room and Photoheliograph without any risk of letting in light. The Janssen slide had, of course, to be carried through from the dark-room to the instrument, but the double doors enabled this to be done very conveniently without interrupting the work in the dark-room.

There being only a single dark-room in the Observatory, it was undesirable to use it in any way as a store or laboratory, and nothing was kept in it beyond the chemicals and appliances actually in use. A dark-room for the preparation of dry-plates, testing baths, &c., was fitted up in a bungalow immediately opposite the Observatory, and here also all preparation of chemicals, cleaning of plates were carried on, and the spare stores kept.

The Photoheliograph stood on an isolated brick pillar in the centre of a circular room 12 feet in diameter, fitted with a revolving dome similar to the other domes. On the wall to the left hand was placed the electric clock-dial worked by a current from the standard clock. The wires connecting the recording tappet-key and Janssen slide with the chronograph were taken through the passage, down the wall and then, passing under the floor, up the pillar of the instrument and fastened in connectors fixed on a shelf near the top of it. Separate pairs of wires for the Janssen slide and for the tappet-key were fixed in the connectors, the ends of the Janssen wires being left loose, so that they could be attached to the slide when in use. The tappet-key was fitted with a pair of scissors, according to a plan devised by Colonel Tennant, so that the act of cutting the thread to set loose the exposing shutter completed the circuit, and thus each exposure was instantaneously recorded on the Chronograph.

Process employed.

It had originally been intended to use the dry-plate process on account of the great convenience it presented in allowing the operations of preparing and developing to be performed at leisure, free from hurry and excitement, as well as for the ease of working the large number of plates required with a minimum establishment.

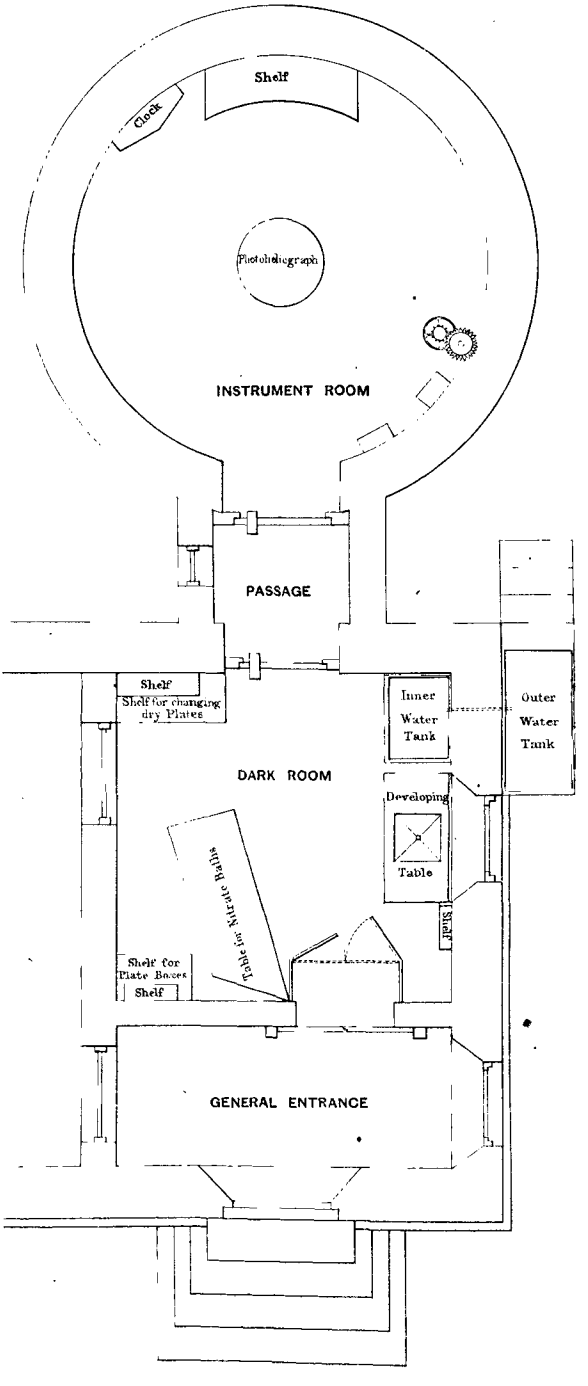
I had never had much experience of dry-plate working, but in view to using the process for the Transit photographs, I made trials of different processes in Calcutta, almost daily, from about the middle of August till the beginning of October, when I left Calcutta to join Colonel Tennant. I found that the beer-albumen process, recommended by Captain Abney and adopted by the English expeditions, was not in many respects so good as other processes, particularly in a great want of sensitiveness. I also found from trials with a rough photoheliograph, made up for the purpose, that the sun-pictures required special conditions, so that a dry process which would answer very well for views, would not answer with the sun, and *vice*

PLAN OF PHOTOGRAPHIC ROOMS

ROORKEE OBSERVATORY

as arranged for observing the Transit of Venus

Scale $\frac{1}{4}$ *Inch* = 1 *Foot.*



versâ; and I could not decide upon any process as giving really satisfactory results with the sun, but hoped that with the proper chemicals and improved appliances to obtain better results at Roorkee. It may, however, be mentioned that most promising results had been obtained from plates prepared with laudanum, either alone, as a dilute solution containing from 30 to 120 minims to an ounce of water, or with the addition of gum arabic or gum tragacanth. I was led to use the laudanum from a statement of Prof. Vogel, that plates prepared with morphia were more sensitive to the comparatively nonactinic rays from the outer part of the solar disc; and though I did not remark any particular superiority in this respect, the laudanum plates were found more sensitive than most of the others tried.

After my arrival at Roorkee, I again tried Abney's process with the chemicals sent out by him, as well as a very good beer-albumen process recommended by Mr. Davies of Edinburgh, which was found better than Abney's in point of sensitiveness, and also the gum-gallic and laudanum processes, which my previous experience in Calcutta led me to believe likely to give good results, but all attempts failed owing to the plates being covered with spots, the cause of which could not be traced, and which resisted all endeavours and careful precautions to avoid them, and were the more perplexing because I had experienced nothing of the kind in Calcutta, though working with no special precautions. Besides the tendency to spots, none of the plates prepared by the beer-albumen, laudanum, gum-gallic and other processes gave quite satisfactory pictures of the sun, but the best results were obtained from a modification of the coffee process recommended by M. de Constant of Lausanne, albumen being substituted for gum to avoid all tendency to blistering. This process was exceedingly simple, and the plates prepared by it were found fairly sensitive and perfectly free from blurring. The plates having received a coating of albumen as a substratum were coated with collodion and sensitised by a somewhat prolonged immersion in a 40-grain silver-bath, then washed in four changes of distilled water, and finally immersed in a sensitising solution, or so called preservative, composed of

Dried Albumen	30 grains	or	1 part.
Sugar	180 „	„	6 parts.
Coffee infusion, made by boiling 1 ounce of coffee, in 12 ounces of distilled water	10 ounces	„ 160	„
Water	10 „	„ 160	„

and then drained and dried without heat.

I may note that the highly bromised collodion recommended by Captain Abney for solar pictures was found very valuable in giving an intense picture with considerable sensitiveness, but owing to the short time between receiving the materials from England and their being used, this collodion had scarcely time enough to ripen properly, and so could not have a fair trial. It was, however, used on the day of the Transit with the above preservative for one of the Janssen and four of the 6-inch plates, and, with the exception of the spots, gave very excellent pictures, fairly sharp and dense, quite free from blurring, and indeed, in some respects, much better than many of the wet plates.

Owing to the difficulty experienced in obtaining satisfactory results with the dry plates, it was resolved to adopt the wet process, and the dry-plate trials and drills were discontinued about three weeks before the Transit. Although the dry-plate process would have been undoubtedly more convenient in some respects, and one was naturally reluctant to give it up after all the trouble taken to perfect a good working method, the change to wet had many advantages in avoiding the very tedious operations of preparing and developing the plates, which alone would have taken up about two days before and after the Transit, and more particularly in enabling the state of the working to be seen throughout its progress, and any defects remedied immediately. Further, the manipulations of the wet process were familiar to all my assistants, and by a division of labour they were able to carry on the work with ease and without the slightest confusion.

The details of the wet process worked on this occasion do not require any special notice beyond a mere outline of the operations.

Preparation of the Plates.

The plates having been numbered on the back with a diamond, were cleaned and then coated with an albumen substratum composed of the white of one egg to a wine-bottle of water. The object of the substratum was to secure the holding of the collodion film to the glass.

Collodion.

The collodion used was a preparation made by Colonel Tennant containing a full proportion of pyroxyline and iodising salts, being composed of

Iodide of Cadmium	40 grs.	or	1 part.
Iodide of Ammonium	40 „	„	1 „
Bromide of Cadmium	40 „	„	1 „
Pyroxyline	160 „	„	4 parts.
Ether	10 oz.	„	120 „
Alcohol	10 „	„	120 „

and giving a denser film and a more intense picture than most of the commercial samples. A few of the plates were taken with a mixture of equal parts of Rouch's and Thomas' collodions, which also worked well.

Nitrate Bath.

The weather being cold, and also to secure as much density as possible without intensifying, the nitrate bath was used rather strong, being 45 grains to the ounce of water. Four baths were provided for the 6-inch plates, and one large one for the Janssen plates. A spare large bath and two small ones were kept in reserve in case of accidents.

Developer.

The developer was a tolerably strong iron developer containing sugar. It was composed of

Protosulphate of Iron	5	parts.
Sugar	5	„
Glacial Acetic Acid	4	„
Spirits of Wine	3	„
Water	100	„

Fixing.

The plates were fixed with the ordinary fixing solution of cyanide of potassium.

The plates were not varnished, as it was considered undesirable to varnish plates intended for future measurement, and also to obviate any chance of the varnished film cracking when removed to England. On this account the plates have not been printed from, as Sir George Airy has directed in his instructions to the English observing parties. Such prints would be of little use except to give a general idea of the results, and of no use at all for measurements, owing to the distortions caused by unequal shrinkage of the paper; but it is proposed to make copies of the negatives on glass, in a copying camera, before shipping them off to England.

Preliminary preparations.

I joined Colonel Tennant at Roorkee on the 13th October, and immediately commenced the necessary preparations. First of all the dark-rooms had to be fitted up with double doors and shelves, water supply arranged, chemicals and apparatus to be unpacked and conveniently stored away. I had also to study the different adjustments of the photoheliograph and acquaint myself with the nature and extent of the work before me, so as to be able to form a plan for carrying it out efficiently. One of the first things to be done was the selection of the glass to be used for the transit plates, so as to avoid as far as possible the use of flawed glasses. The whole stock was carefully gone over before any of the plates were given out for use, and about 200 of the best were selected and put aside.

About the 21st October, arrangements were sufficiently advanced to begin the training of the assistants, and preliminary drills were started with a view to ascertaining the most convenient mode of working, supposing dry plates to be used. In these drills sensitive dry plates were not used, only plain glasses; but every twelfth plate was prepared by the wet process and developed. In subsequent drills, however, every fifth plate was prepared wet and developed in order to see if all adjustments were correct; and this system would have been followed throughout had the dry plates been used as originally proposed.

The dry-plate trials began on the 28th October, as soon as the arrangements of the dark-rooms were sufficiently advanced to admit of it, and were continued till about the 17th November, when it was considered advisable to try the wet process owing to the spotty and unsatisfactory results given by the dry plates. After a few trials it was found that with four baths there was no difficulty whatever in keeping up a constant supply of plates at intervals of two minutes, and the advantages of working the wet-plate system became so manifest, that it was definitely decided to adopt it. The dry-plate trials and drills were therefore discontinued, and the wet-plate drills regularly practised daily, as circumstances permitted, either in the early morning or after breakfast, sometimes twice on the same day, but always as far as possible between the hours of 7 and 12, during which the transit would take place. In these drills most attention was given to practising the amounting of the Janssen slide by signal, and again unmounting it and resuming the ordinary plates in the interval.

On the 28th November, being all fairly well practised, and the preliminary programme of operations drawn up, the first full rehearsal was gone through with fair success, and several points were noticed as requiring modification and practised in succeeding drills.

On the 2nd December, a second full rehearsal was gone through very successfully, and after a few more drills a final rehearsal took place on the 6th, when every thing worked quite satisfactorily, 120 six-inch and 6 Janssen plates being taken in the course of the time it was estimated the transit would occupy.

The preparations for the transit itself had already been commenced about the 2nd, and glasses were cleaned, baths prepared and tested, and adjustments of the instruments looked to. Unfortunately, the weather for a few days before the transit was cloudy and hazy, and most unfavourable for trials of chemicals, and some difficulty was experienced on this score. About a dozen six-inch and four Janssen plates were prepared by the coffee-albumen process to be used in case of necessity, and all necessary preparations were finally completed by the afternoon of the day before the transit.

During the progress of the drills and other preparations, a great deal of time and anxious care had to be devoted to the cleaning and focal adjustment of the instruments, and particularly to the Janssen slide, which for a long time worked unsatisfactorily, and even up till the last gave cause for anxiety.

In the first place, the Janssen plates were found to be fogged and so indistinct as to be almost useless. This was due partly to the reflection of light from the polished surface of the wood-work of the slide itself, and the brass-work of the revolving disc carrying the exposing aperture, and partly to the red glass of the revolving disc being pervious to chemical rays. The first was partially obviated by thoroughly dead-blacking these and all other surfaces capable of reflecting light on to the sensitive plate, and the second by substituting a thick piece of dark ruby glass for the thin and light coloured piece originally supplied. Even with these precautions a little white light found its way on to the plate between the revolving disc and the wood-work of the slide, which were at a greater distance apart than appeared necessary, though the entrance of light might have been easily obviated by fitting the revolving disc with a flange running in a groove cut in the wood-work of the slide.

A greater difficulty connected with the working of the Janssen was the fact of the front surface of the revolving plate-holder rubbing against the wooden shutter of the slide; and this was removed by scraping the wood-work. The catches holding the ring of the plate-holder in its place were also found to rub against the spindle of the winch. Partly owing to the strain caused by this friction, the clock-work was liable to get out of order and required frequent looking after and repair.

The hanging counterpoise at the object-glass end of the telescope was found to swing and induce a tremor in the instrument, spoiling the definition of the pictures; it was therefore replaced with a rough, but efficient, substitute in the shape of a canvas bag, the ends of which were filled with shot. This was merely hung over the end of the telescope at the proper balancing point and kept the tube perfectly steady.

Towards the end all these difficulties were surmounted, and on the day of the Transit the Janssen slide worked very satisfactorily.

The programme of operations, as revised after the last rehearsal, was as follows:—

Programme of the Photographic Observations, Transit of Venus, at Roorkee, December 8th (9th Civil) 1874.

Process.

1. As the dry-plates have not been found to give satisfactory results, and there is no difficulty in working the ordinary wet-plate process, the latter will be adopted. It will, however, be desirable to have a small supply of dry-plates prepared in reserve in case of accidents, and also to be used, if necessary, at times when the supply of wet-plates cannot readily be kept up.

2. It has been ascertained that with four silver baths a constant supply of wet-plates at intervals of two minutes can be maintained. Arrangements must, therefore, be made for having four baths in good order, for the six-inch plates, and a large bath for the Janssen plates. At least two baths, one large and one small, must be kept in reserve in case of one of the other baths getting out of order, or becoming temporarily unfit for use. A sufficient supply of clear collodion must also be prepared so as to allow of every plate being coated with fresh collodion, the same collodion not being used twice—about two pints will be sufficient; 150 ounces of developer and a sufficient quantity of cyanide solution for fixing will also be prepared. The plates will not be intensified, but the greatest degree of intensity possible should be obtained from the first development.

3. Some days before the Transit, 120 six-inch glasses will be selected from those set by as the best, and will be numbered with a diamond in one corner, consecutively from 1 to 120. A reserve of 30 or 40 plates will also be selected and marked with a cross in one corner. The whole of these plates as well as a dozen circular Janssen plates will be carefully cleaned and then albumenised on the unmarked side.

4. The plates thus numbered and albumenised will be arranged in order in five boxes, holding two dozen each, with the marked corners running along the upper left-hand side of the boxes. Each box will be legibly marked with a distinguishing letter and the numbers of the plates contained in it, thus $\frac{A}{1\text{-}24}$. A sixth box, containing marked plates, will be kept in reserve to be used if required, and any plates so used must be numbered at the time with their proper number in order of sequence.

5. The utmost care must be taken that the proper order of sequence of the plates is preserved throughout the operations, but if, by accident, a plate should be left out, or any alteration in sequence occur, a note must be made of it at once and given to the Officer in charge, who will duly record it. Should any of the plates originally numbered be broken during any of the operations, or put aside from any other cause, their places must be filled up from the marked plates, and they must be numbered in their proper order of sequence.

6. During the operations it may be advisable to expose dry plates, particularly before and after the interval of relaxation about mid-transit, or to quickly supply the place of a spoiled wet-plate. In order to secure the proper sequence of these plates they should, if possible, be numbered in their proper order, following the numbers of the wet plates immediately preceding them, the corresponding cleaned and numbered plates being passed over. When dry plates are used, the Officer in charge must always be informed, so that he may change the aperture of the exposing shutter.

7. When developed, the plates must be placed in the draining racks in the order in which they were taken, and carefully placed aside till after the Transit.

Distribution of duties.

8. The distribution of duties will be as follows:—

Captain Waterhouse will remain at the Photoheliograph, expose the plates and record the time at which each is taken, carefully noting any variation in the intervals or other noteworthy circumstances. In case of the exposing shutter sticking so that the plate is not exposed at the time recorded by the Chronograph, he will record the time at which the signal was made, and cross it out with a remark "slide stuck," and at once proceed to attach another loop and record the time when the plate was actually exposed. At every sixth plate he will replace the cross-wires by the reticule. He will be responsible that all the adjustments of the instrument are in good order the day before the Transit. He will be assisted by a native khalassie to hand the plates in and out, turn the dome, &c.

9. Sergeant Harrold will develope the plates and exercise a general supervision in the dark room. He will take special care that the plates are ranged in their proper order of sequence as developed, and will note in writing any variations. Should any change in the exposures, or in the adjustment of the pictures on the plates, be necessary, he will at once inform the Officer in charge.

10. Corporal George will coat the plates with collodion and put them in the baths. He will be responsible that the plates are taken up in proper order, as arranged in the boxes, and will at once report any change. Should it be necessary to pass over any of the marked and numbered plates, he will see that the plates substituted for them are properly numbered in order, as described in paragraph 5. In coating the plates with collodion he will observe to keep the numbered corner of the plate downwards and at the upper right-hand corner, pouring off the collodion at the lower right-hand corner, so that when the plate is placed in the slide, the number may be on the back, or uncoated side, of the plate, at the *upper* left-hand corner of the slide, and the thick collodion corner at the *lower* left-hand corner, thus furnishing a ready means of ascertaining the proper position of the sun's image on the plates.

11. Private Fox will take the plates out of the baths, place them in the dark-slides, in the manner described in the last paragraph, and pass them into the dome. He will also carry the Janssen slide into the dome, place on and take off the No. 1 counterpoise and carry the Janssen plate back again for development. Should there be any delay in a wet-plate being ready at the proper time, he will keep a dry-plate in readiness and send it in, notifying the change; and this he should do at all changes from wet to dry, or *vice versâ*.

12. One khalassie will remain in the dark-room to assist in handing the dark-slide backwards and forwards, and will put on the No. 2 counterpoise when the Janssen slide is used. A second khalassie will remain in the space between the double-doors and pass the dark-slides in and out through the boxes in the doors. The third khalassie will remain in the dome to hand the plates to the officer in charge, turn the dome, &c.

13. The dome will be opened at 6 A. M. by the orderly of the week, who will uncover the instrument and have all in readiness for commencing work at about ¾ to 7.

14. The officer in charge will see that everything is ready for work and verify the adjustments of the Photoheliograph and the electrical communications with the Chronograph, which should all have been carefully examined and adjusted two or three days before the Transit. He will also compare the time of the electric clock-dial in the dome with the standard-clock, and also with the chronometer, in case of the clock breaking down.

15. The following routine of taking the photographs will be strictly observed, whatever the state of the weather, but the officer in charge will exercise his discretion in regulating the intervals between the exposures, in the case of the weather being cloudy, so as to avail himself of a passing gleam of clear sunshine.

16. It has been computed that the first contact will take place about 12h. 10m. 47s. (sidereal time) or 7h. 13m. 7s. (mean time.) The order for commencing the preparation of the plates will be given about 11h. 55m., and the work of the day will commence with the exposure of a Janssen plate for trial of the apparatus, after which four of the six-inch plates will be exposed at intervals of two minutes. About the time of bisection, at 12h. 24m., a second Janssen will be exposed, to be followed, as before, by 4 six-inch plates, and a third Janssen plate will be prepared in readiness for the first internal contact at Ingress, about 12h. 30m., for which a signal will be given by Colonel Tennant; and after this the regular work of photographing the Transit, at intervals of two minutes, on the six-inch plates will be carried on uninterruptedly, with the exception of the intervals to be noted hereafter; every sixth plate

being taken with the reticule instead of the cross-wires, until a few minutes before the second internal contact at Egress, about 16h. 38m., when the Janssen slide will again be mounted in readiness, and await the signal for exposure to be given by Colonel Tennant. Janssen plates will also be taken about the times of bisection and last contact at Egress, and during the intervals between the exposures of these plates, 4 six-inch plates will be taken as at Ingress. It must be borne in mind that the photographing of the internal contact at Egress with the Janssen apparatus is all-important, and ample time must be allowed to make sure of everything being in readiness to expose the plate at the moment the signal is given.

17. At 14h. a signal will be given by the officer in charge for a break of 15 minutes in the observations. All wet-plates then under preparation will be exposed, and dry-plates will be sent in until all the wet-plates have been developed and everything is ready for opening out the doors. In like manner, after the break, dry-plates will be sent in until the wet-plates are ready.

18. After the Transit the officer in charge will examine and verify the sequence of the plates in the racks, and have them carefully dried and then replaced in proper order in the plate-boxes.

Operations of the 8th (9th Civil.)

The operations during the Transit were carried out in accordance with the foregoing programme with the exception that, instead of 4 six-inch plates being taken between the Janssen's, only two were taken, in order to obviate all risk of being too late. There was also an error of sequence, the plates marked Nos. 86 and 87 having been taken after Nos. 88 and 89. This was detected in going over the plates, after the Transit, from the position of the plates in the drying racks, and, when confirmed by measurement, duly recorded.

Results.

The total number of six-inch plates recorded is 109, but of these, two (Nos. 103 and 104) failed totally, and Nos. 1 and 2, taken at the very commencement of the Transit, are so faint as to be nearly useless; they have, however, been put up with the rest, making in all 107 photographs.

Many of the photographs show very marked irradiation round the planet, and in some few cases there is an appearance resembling streamers issuing from different parts about its limb. In plate No. 105, taken about the time of bisection at Egress, the whole disc of the planet is just visible with a very faint trace of a bright boundary, but it is remarkable that in the Janssen plate No. 4, taken just before this plate, the disc of the planet is not *distinctly* visible in any of the pictures, and is, perhaps, only doubtfully so in one or two of them. With a few exceptions, at every sixth plate the reticule was substituted for the cross wires.

General Remarks.

I have but little to add in the way of general remarks. The arrangements of the rooms and programme of operations proved efficient and left little to be desired.

Of the Photoheliograph I can say little. It was no doubt an excellent and carefully finished instrument, but I think that for continuous work extending over some hours, during which the adjustments were constantly being disturbed by the insertion and withdrawal of the dark-slides, it should have been more firmly mounted in consideration of its great length than it was. The dark-slides were found to be very stiff and did not appear to have been originally made of the same size as the focussing screen, which fitted perfectly, and consequently they required considerable filing down to make them fit, at the risk of losing sharp definitions.

I think the pattern of dark-slides adopted for the equatorial camera used at Dodabetta for the Total Eclipse of 1871 was far preferable and much more convenient for easy insertion and withdrawal of the slides through a long series of observations.

I have already noted some of the defects of the Janssen slide, the want of blackening of the polished surfaces, the friction between the revolving disc and the case, and the consequent irregularity of the clock-work; but these defects can easily be avoided in future. The idea is admirable, and, as far as I can judge from results, well adapted for the object in view, but should such a slide be used at the next Transit, it would, I think, be desirable that arrangements should be made for the automatic movement to be continued or distributed at intervals over a much longer period—I should say for at least three or four minutes, perhaps even five—so that all the phenomena attending the contact may be fully observed and recorded. The mounting of the slide necessitates the alteration of the adjustments of the telescope for taking the six-inch plates, thus stopping such observations for some time before and after the critical period, and it is therefore desirable that each operation with the Janssen slide should extend over as long a period as possible. If it were feasible to construct the slide so that the plates could be easily changed, it would be better still; and in that case three or four plates might be taken in quick succession during five or six minutes about the time of contact, but to do this, an arrangement would be required by which the revolving disc could be at once brought into the proper position for exposing the successive plates, instead of having (as in the present slide,) to be reversed through *an entire revolution*, which alone takes nearly half a minute.

J. WATERHOUSE, *Captain,*
Assistant Surveyor General,
In charge Photographic Observations.

Roorkee, 18*th December* 1874.

Report by CAPTAIN J. WATERHOUSE, *Assistant Surveyor General, in charge Lithographic Branch.*

1. The amount of work turned out during the year, as compared with the previous year, is shown in the table below :—

	1873.	1874.
New drawings executed on transfer paper	274	271
Do. do. do. on stone	25	37
Color stones prepared	139	142
Subjects printed	481	602
Complete copies	1,59,652	2,14,163
Pulls	2,38,712	2,77,501
Sheets of forms, &c., for type	594	2,100
Complete copies	2,75,334	1,95,876
Pulls	3,80,693	3,28,583

2. The cost of the establishment and contingencies has amounted to Rs. 40,617-9-0, or Rs. 43-12-8 more than last year.

3. The color printing of the engraved sheets of the Atlas of India and other departmental and extra-departmental maps and publications has continued to make good progress during the year, and the new preliminary map of the Bombay Presidency, two geological maps of the Trans-Indus Salt Region, and the province of Pegu, and a map showing the distribution of the forests in British Burmah, all of large size, are excellent specimens of work.

4. During the year, Mr. Fraser Crawford's method of drawing lithographic transfers over photographic prints made with gelatine and bichromate of potash, alluded to in my report of the Photographic Branch for last year, has been largely used, and is found very valuable in making copies or reductions of subjects unsuited for photozincography. Some experiments have also been made with a method of making transfers of shaded chalk drawings on the grained transfer paper prepared by Messrs. Maclure and Macdonald, and I am much indebted to Major Godwin-Austen, who has used the paper with great success, for a supply of it and information regarding its use.

5. I have again the pleasure of reporting on the continued good conduct and devotion to their duties shown by Messrs. Jevezy, Niven and Lepage, and by the native assistants and draftsmen.

J. WATERHOUSE, *Captain,*
Assistant Surveyor General,
In charge Lithographic Branch.

Abstracts of the Drawings executed in the Surveyor General's Office, Lithographic Branch, from 1st January to 31st December 1874.

Scale.	New Maps, &c., the lithographic drawings of which were completed during the present year.	Size.	No. of Sheets.	Remarks.
	GENERAL MAPS.			
8 miles = 1 inch	Western Bengal, Sheets Nos. 11, 12, 13, 15, 16 and 17.	Imperial ...	6	
128 „ = 1 „	Index to the Sheets of the Atlas of India, squares drawn only.	Ditto ...	1	
8 „ = 1 „	Preliminary Map of Bhootan	Double Elephant ...	1	
	DISTRICTS.			
4 miles = 1 inch	District Darjeeling	Double Elephant ...	1	
„ = „	„ Bhundarah (a portion drawn) second edition.	Antiquarian ...	1	
8 „ = 1 „	Skeleton Map of Bhaugulpoor Division ...	Double Royal ...	1	
4 „ = 1 „	„ „ of District Rungpoor ...	Atlas ...	1	
4 „ = 1 „	„ „ „ Dinagepore ...	Ditto ...	1	
4 „ = 1 „	„ „ „ Bograh ...	Super Royal ...	1	
4 „ = 1 „	„ „ „ Moorshedabad ..	Atlas ...	1	
4 „ = 1 „	„ „ „ Pubna	Super Royal ...	1	
4 „ = 1 „	„ „ „ Maldah ...	Imperial ...	1	
4 „ = 1 „	District 24-Purgunnahs { Corrections, boundaries, margin lines drawn.	Atlas ...	1	By photo transfer from engraved plates of the Atlas of India.
4 „ = 1 „	„ Jessore Ditto	Antiquarian ...	1	
4 „ = 1 „	„ Nuddeah Ditto	Atlas ...	1	
4 „ = 1 „	„ Pubna Ditto	Super Royal ...	1	
4 „ = 1 „	„ Bograh Ditto	Ditto ...	1	
4 „ = 1 „	„ Rajshahye Ditto	Imperial ...	1	

Abstracts of the Drawings executed in the Surveyor General's Office, Lithographic Branch, from 1st January to 31st December 1874—(continued).

Scale.	New Maps, &c., the lithographic drawings of which were completed during the present year.	Size.	No. of Sheets.	Remarks.
	Revenue Survey Maps.			
1 mile = 1 inch	Oudh, Sheet No. 38, Districts Gondah and Bharaich.	Super Royal ...	2	
1 „ = 1 „	District Bijnour, Sheet No. 4	Double Royal ...	1	
1 „ = 1 „	„ Chanda, „ „ 7	Ditto ...	1	
1 „ = 1 „	„ Lohurdugga, Sheets Nos. 11, 14, & 15	Ditto ...	3	
1 „ = 1 „	„ Bareilly, Sheet No. 2 (re-drawn)	Ditto ...	1	
1 „ = 1 „	„ „ Sheets Nos. 5, 6, 8, & 9 ...	Ditto ...	4	
1 „ = 1 „	„ Moorshedabad, Sheets Nos. 1, 2, 3, 4, 6, 7, 9 & 11.	Ditto ...	8	
1 „ = 1 „	„ Bhaugulpoor, Sheets Nos. 1, 2, 3, 4. 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 & 16.	Ditto ...	16	
1 „ = 1 „	„ Nowgong, Sheets Nos. 1, 2, 3, 4, 8, 11 & 13.	Ditto ...	7	
	Plan of Cantonment and Civil Station.			
10 inches = 1 mile	Plan of Civil Station and City of Dumoh ...	Imperial ...	1	
	Barrack Plans.			
	Plan of Asseergurh Fort	Double Royal ...	4	
			71	
	Geological Maps.			
4 miles = 1 inch	Geological Maps of Indian Atlas, Quarter Sheets Nos. 76 S. W. and 77 N. W., Geological lines, &c., drawn.	¼ Sheet Atlas ...	2	
4 „ = 1 „	„ „ of Rajmahal Hills, correction, border lines, &c., drawn.	...	1	
	„ „ of Dumbal Hills, correction, border lines, &c., drawn.	...	1	
			4	
			75	
	Miscellaneous Drawings.			
	Public Works Department plans ...		1	
Various scales	Bengal Government maps and plans ...	Various sizes ...	20	
„ „	Foreign Department maps and plans ...	ditto ...	13	
„ „	Archæological Survey plans and drawings ...	ditto ...	40	
„ „	Telegraph Department diagrams, &c. ...	ditto ...	30	
„ „	Department of Revenue, Agriculture and Commerce maps, plans, &c.	ditto ...	14	
„ „	Miscellaneous maps and plans, &c., &c. ...	ditto ...	115	
			308	
			No. of tint stones prepared	
	Coloring.			
32 miles = 1 inch	Sketch Map of the Provinces comprising the Lieutenant-Governorship of Bengal,	Double Elephant ...	3	
„ „	Preliminary Map of Bombay Presidency ...	ditto ...	2	
„ „	Ditto ditto plate transferred	ditto ...	3	
„ „	Sketch Map of India, Sheets Nos. 1 to 6 ...	ditto ..	19	
128 „ „	India showing the progress of the Survey of India.	Imperial ...	5	
„ „	Index to the sheets of the Atlas of India for 1874.	ditto ...	1	
8 „ „	Map of Western Bengal, Sheets Nos. 11 and 12	ditto	4	
4 „ „	Map of Indian Atlas, Quarter Sheets Nos. 3 N.E., 34 N.E., 51 S.E., 72 S.E., and 93 N.E.	¼ Sheet Atlas ...	12	
„ „	District Dumoh ...	Imperial ...	1	
„ „	Ditto Nuddeah ...	Atlas ...	1	
„ „	Ditto Jessore ...	Antiquarian ..	1	
„ „	Ditto Rajshahye ...	Imperial ...	1	
„ „	Ditto Bograh ...	Super Royal ...	1	
„ „	Ditto 24-Pergunnahs ...	Atlas ...	1	
„ „	Ditto Pubna ...	Super Royal ...	1	
1 „ „	Oudh Revenue Survey, Sheets Nos. 23, 24 and 38	ditto ...	6	Line of levels.
„ „	District Bijnour, Sheets No. 5 ...	Double Royal ...	1	
„ „	Ditto Bareilly, Sheets Nos. 1, 7 and 10 ...	ditto ...	3	
	2 Specimen sheets of Cadastral Survey ...	Imperial ...	4	
32 „ „	Sketch Map of the Provinces comprising the Lieutenant-Governorship of Bengal, illustrating the Report on the cultivation of Jute in 1874.	Double Elephant ...	2	

Abstracts of the Drawings executed in the Surveyor General's Office, Lithographic Braach, from 1st January to 31st December 1874—(concluded).

Scale.	New Maps, &c., the lithographic drawings of which were completed during the present year.	Size.	No. of Sheets.	Remarks.
22 miles=1 inch ...	Sketch Map of India, sheets Nos. 1 to 6, showing financial circles..	ditto ...	6	
16 „ „	The Presidency Division, comprising the 24-Pergunnahs, Nuddea, and Jessore.	½ Sheet Imperial ...	2	
„ „	Map of Burdwan Division, comprising the Districts of Burdwan, Beerbhoom, Bankura, &c.	Imperial ...	1	
64 „ „	The Provinces of Bengal, Béhar, and Orissa under the jurisdiction of Lieutenant-Governor of Bengal with Provinces of Assam under Chief Commissioner.	Super Royal ...	2	
8 „ „	Map of Nuddea Division ...	Atlas ...	1	
120 „ „	Map of India to illustrate the Annual Report of the Sanitary Commissioner for 1874.	Imperial ...	1	
16 „ „	Forest Map of British Burma ...	ditto ...	1	
8 „ „	Sketch Map of the Islands in the Bay of Bengal.	Super Royal ...	2	
128 miles=1 inch ...	Map of India, shewing arsenals, magazines, depôts, &c.	Imperial ...	2	
10 „ =1 „ ...	Sketch of Chota Nagpore to accompany the annual return and the Report of the Ranchee circle of Vaccination.	Imperial ...	2	
8 „ =1 „ ...	Sketch map of Dacca and Fureedpore districts, shewing the Vaccination operations in 1872-73 and 1873-74.	Super Royal ...	2	
8 „ =1 „ ...	Sketch map of the Metropolitan Vaccine Circle shewing the operations of 1873-74.	Atlas ...	2	
	Map shewing the existing circles of Vaccination in their relation to the Metropolitan circles.	½ Sheet Super Royal	3	
64 „ =1 „ ...	Map of Bengal, shewing the tracts affected by the famine of 1874.	Super Royal ...	1	
8 „ =1 „ ...	Settlement map of district Bahraich, Nos. 1 & 2	Atlas ...	5	
4 „ =1 „ ...	Map of Bamun Pokri plantation reserve ...	½ Sheet Super Royal	1	
	Rain map of India		2	
	Chart of rainfall in 1873		1	
	Weather chart for April 1873		1	
	„ „ for June „		1	
	„ „ for August „		1	
	Wreck chart of the coast of India ...		1	
	Nine military maps for Colonel Paget's work		9	
	Plan of Berhampore drainage scheme ...		1	
	Chart of the Chittagong river		1	
	Small plan of Calcutta		1	
	Map of Afghanistan, shewing salt range ...		1	
	View of salt valley at Bahadur Kheyl ...		1	
	Drawing of antiquities of Orissa, Plate No. 33		1	
	„ of „ of „ „ No. 55			
	plan of Cuttack		1	
			128	
	COLORING GEOLOGICAL SURVEY MAPS.			
½ inch=1 mile ...	Geological map of Trans-Indus salt region ...	Double Royal ...	4	1 color remaining.
8 mile=1 inch ...	„ Pegu province, British Burmah.	Double Elephant ...	6	
256 „ =1 „ ...	Map of India, shewing present state of progress of the geological survey for 1874.	Foolscap ...	3	
	View of salt valley at Bahadur Kheyl ...	½ Sheet do. ...	1	
			14	
			142	

ABSTRACT.

	Sheets.
General and District maps	... 23
Revenue Survey maps	... 43
Plan of cantonment and civil station	... 1
Barrack plans for Secretary of State	... 4
Geological maps, lines, &c., drawn	... 4
Miscellaneous drawings	... 233
Color stones prepared	... 142
TOTAL OF SHEETS	... 450

Abstract of printing executed at the Surveyor General's Office, Lithographic Branch, during the year 1874.

Subjects.	No. of Sheets.	No. of Copies.	No. of Pulls.
Lithographic Branch.			
District and general maps	56	17,679	28,967
Revenue Survey sheet maps, 1 mile=1 inch	59	13,745	19,656
Cantonment plans	2	570	570
Block plan of barracks for Secretary of State	26	1,380	2,392
Reprints of old maps	77	13,210	18,820
Miscellaneous maps	70	24,550	43,706
Do. plans, sketches, &c.	395	1,38,902	1,47,795
Tints printed on geological maps and plans	7	4,117	15,595
TOTAL ...	602	2,14,153	2,77,501
Type Department.			
Departmental orders, &c	14	2,647	2,897
Memoranda and forms for use of the Department	501	1,24,621	1,87,302
Forms of Topographical and Revenue Surveys	85	62,608	1,32,384
Transfers of headings, foot-notes, references, &c., to published maps	1,500	6,000	6,000
TOTAL ...	2,100	1,95,876	3,28,583

Statement of cost of Lithographic Branch, Surveyor General's Office.

	Rs.	A.	P.
Permanent establishment	34,946	13	1
Contingent expenses	3,841	1	11
Extra contingencies	1,829	10	0
	40,617	9	0

J. WATERHOUSE, *Captain*,
Assistant Surveyor General,
In charge Lithographic Branch.

SURVEYOR GENERAL'S OFFICE,
LITHOGRAPHIC BRANCH;
Calcutta. 1st January 1875.

No. 332.

Extract from the Proceedings of the Government of India in the Department of Revenue, Agriculture, and Commerce, dated Simla, the 14th May 1875.

SURVEYS.

READ—

Letter from the Surveyor General No. 118A, dated 15th January (received on the 26th April 1875) submitting his annual general report on the operations of the Topographical Surveys of India and of his head-quarter offices for 1873-74.

OBSERVATIONS.

Seven parties were employed as in the previous year, and the field of operations was the same, the work being advanced in compact blocks in continuation of that already completed. The following table shews the results of the season's survey as compared with that of the previous year:—

	Final topography.	Triangulation in advance.	Cost.
	Square miles.	Square miles.	Rs.
Season 1872-73	25,327	18,930	4,49,896
„ 1873-74	24,103	19,623	4,25,041

The outturn of work is nearly the same, there being a small decrease in the area of final topography and a slight increase in the area triangulated in advance. The mileage rate was a little lower than in the previous year, being Rs. 17-10-0 against Rs. 17-12-0, and the total outlay shews a decrease of Rs. 24,855.

2. The decrease in the area finally surveyed is due to a smaller outturn in the area accomplished by No. 6 party, employed on the exploration of the Eastern Frontier in the Naga Hills and the Manipur State. Great difficulties have to be encountered in this survey, and when allowance is made for these, the outturn of both years has been satisfactory.

3. There has been a large increase in the number of points fixed and heights determined trigonometrically, as shown below:—

	No. of points fixed.	Heights determined.
1872-73 ...	1,885	1,365
1873-74 ...	2,276	1,965

4. The progress made in the drawing, geographical, compiling and engraving branches, under the efficient supervision of Mr. James, is satisfactory.

5. The work in the photographic and lithographic branches under the charge of Captain Waterhouse has largely increased and has, as usual, been successfully performed.

6. It is to be regretted that the photo-collotype process has not been found sufficiently successful for the reproduction of maps, and it is hoped that the experiments which are being made to utilise the process for other purposes will succeed.

7. The results of the season, on the whole, are very satisfactory, and the Governor General in Council considers that great credit is due to Colonel Thuillier and all the officers referred to in paragraph 58.

ORDER.—Ordered that a copy of the above Resolution be forwarded to the Surveyor General of India for information,

(True Extract.)

Secretary to the Government of India.

Rxd.—F. J. B.

1875.

DEPARTMENT OF REVENUE, AGRICULTURE, AND COMMERCE.

SURVEYS.

RESOLUTION.

No. 332.

Dated Simla, the 14*th May* 1875.

Diary No. 255.

SUBJECT.

REVIEW of the Annual General Report on the operations of the Topographical Surveys of India and of the Head-quarter offices of the Surveyor General of India for 1873-74.

GENERAL REPORT

ON THE

Topographical Survey of India,

AND OF THE

SURVEYOR GENERAL'S DEPARTMENT,

FOR SEASON

1876-77.

BY

MAJOR-GENERAL THUILLIER, C.S.I., F.R.S., &c.,

SURVEYOR GENERAL OF INDIA.

SUBMITTED TO THE GOVERNMENT OF INDIA, DEPARTMENT OF REVENUE, AGRICULTURE AND COMMERCE.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING.
1878.

CALCUTTA:
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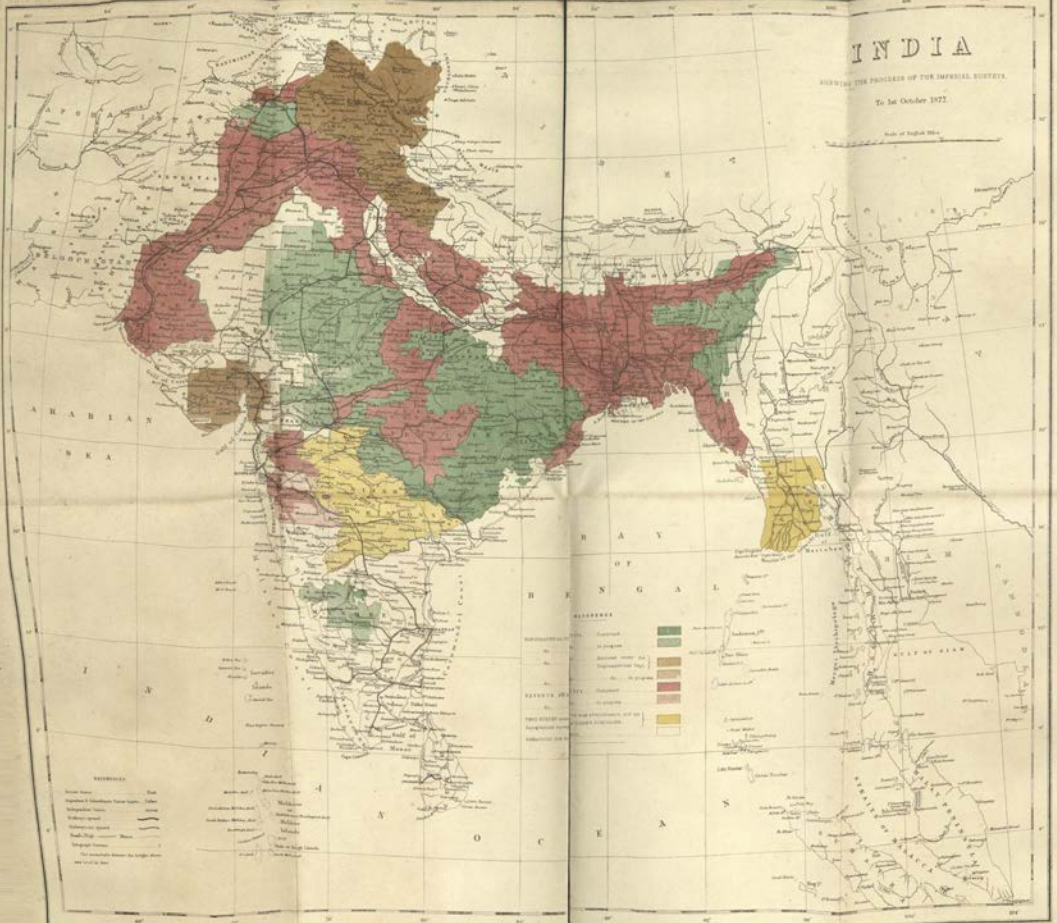
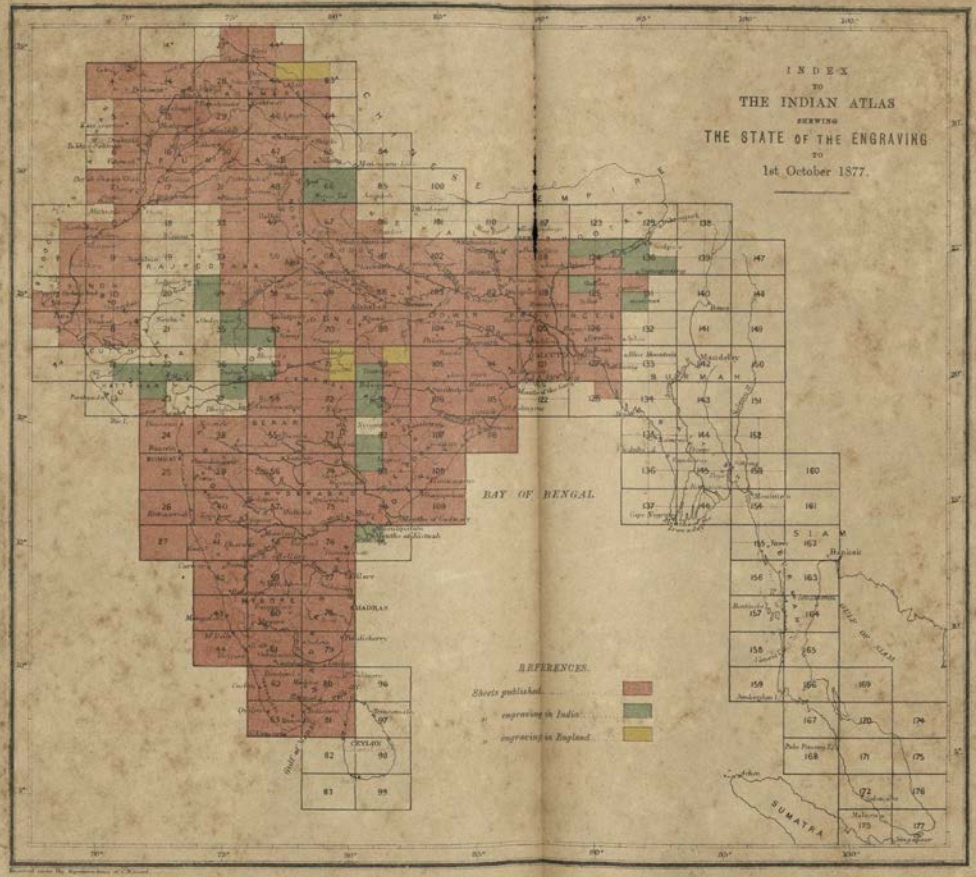

INDIA
SHEWING THE PROGRESS OF THE IMPERIAL SURVEYS.
To 1st October 1872.
ARABIAN
SEA
BAY
OF
BENGAL
INDIAN
OCEAN
REFERENCE

ACCOMPANIMENT TO SURVEYOR GENERAL'S REPORT FOR 1876-77



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Surveyor General's Office, Calcutta.
April 1877.

GENERAL REPORT

ON THE OPERATIONS OF THE

Topographical Surveys of India,

AND OF THE

SURVEYOR GENERAL'S DEPARTMENT,

FOR SEASON

1876-77.

Dated Calcutta, 28th December 1877.

Introductory remarks.

THIS review of the operations of the Imperial Topographical Surveys of India for the professional season 1876-77, and on the work performed in the several branches of the Surveyor General's Head-Quarters Office for the year 1877, is submitted, in continuation of the report dated 4th December 1876, and with it is included a very brief review of the various operations conducted during my own administration of the department as Surveyor General of India from 1861, and as Superintendent of Revenue Surveys from 1847, which it may be useful to place on record on the occasion of my resignation of the appointment I have so long had the privilege and honor to hold, and on making over charge to my successor, Colonel J. T. Walker, C.B., R.E., Superintendent of the Great Trigonometrical Survey, whose appointment as Surveyor General from the 1st January next was conveyed in the letter as per margin.

Revenue, Agriculture, and Commerce Department No. 605, dated 12th October 1877.

Parties employed.

2. During the past working or field season, the number of executive parties was unchanged, and numbered from 1 to 7 in Northern India, and two others (8 and 9—*vide* paragraph 4 of the report for season 1875-76) were employed in the Mysore State; but on return from the field, No. 3 Party, Central Provinces and Vizagapatam Agency Survey, was, on the completion of its allotted work, broken up from the 10th May 1877 and absorbed, and No. 4 Party, North-Eastern Division, Central Provinces Topographical Survey, was also subsequently (from 30th September 1877) broken up and amalgamated with No. 7 Party, Rajputana Topographical Survey,—thus leaving only five parties for future employment in Northern India; while, owing to the famine in Mysore, the two parties, Nos. 8 and 9, have been reduced and combined to form a single one, so that at the present time the Imperial Topographical Surveys are reduced to only six parties.

Index maps to illustrate progress.

3. The several index maps attached, represent the areas allotted to each party and the progress each has made up to date, while the Map of India shews the total general progress of the combined Imperial Surveys in the three branches, Topographical, Trigonometrical, and Revenue.

4. During the season under review the total out-turn of the Topographical Surveys amounts to 18,909 square miles, and the several different scales on which the work has been conducted for the reasons given elsewhere is shewn in the margin.

Season's total out-turn of work.

13,928	square miles on	1	inch	=1 mile.
3,942	" on	½	"	=1 "
971	" on	2	inches	=1 "
55	" on	4	"	=1 " *
13	" on	6	"	=1 " *
18,909	Total square miles.			

* These represent Forest Reserves and City and Cantonment Surveys.

5. The triangulation completed, covers 22,119 square miles. Observations were taken at 438 stations, from which 3,463 points and 1,880 heights were trigonometrically fixed, giving on an average one fixed point for every 7 square miles, and one height for every 22 square miles: these averages are good, considering that a considerable portion of the ground triangulated will be surveyed on the ½-inch scale.

6. All the season's topography is stated by the Executives to have been accurately delineated, and was duly tested in the field either by check routes extending over 1,863 linear miles, or by *in situ* examinations. The total amount of fair mapping completed by the several parties, covers on the different scales 20,237 square miles, in which is included a portion of the last season's survey which could not be rendered before in complete standard sheets, and some revised mapping in the Naga Hills, rendered necessary by fresh information obtained during the season under report.

Season's final fair mapping.

7. This area of fair mapping is contained in 52 standard sheets, and will furnish excellent materials for the completion of, or additions to, the sheets of the Indian Atlas detailed in the margin. Much of the geography obtained in the Naga Hills on the Eastern Frontier of Assam, and in the Central Provinces in district Bálághát and the Native State of Bustar, is perfectly new, and a great portion of the remainder in Malwa, Khandesh, and Rajputana furnishes reliable topography, in place of the very rough routes and sketches from which the old existing maps were compiled. All the season's fair mapping has been rendered in a satisfactory and complete manner, and bears favorable comparison with that of the previous season. The standard sheets prepared for the photozincographic process have re-produced very satisfactorily, and are well advanced towards immediate publication.

No. 1	Party—3	standard sheets,	scale	1	inch=1	mile,	part of Atlas sheet 35.	
" 2	" 3	"	"	2	inches and 1	inch=1	mile, parts of Atlas sheets 36 and 37.	
" 3	" 9	"	"	½	inch=1	mile,	part of Atlas sheet 92.	
" 4	" 6	"	"	1	"	"	"	71, 72 and 91.
" 5	" 6	"	"	1	"	"	"	53.
" 6	" 14	"	"	½	"	"	"	138.
" 7	" 8	"	"	½	"	"	"	32 and 33.
" 8	" 1	"	"	1	"	"	"	60.
" 9	" 2	"	"	1	"	"	"	59.

8. The cost of the season's operations amounts under all heads to Rs. 4,81,958, inclusive of Rs. 1,21,161 paid by the Mysore State, so that the charge to the Imperial Revenue is only Rs. 3,60,797, or Rs. 25,535 less than in season 1875-76. The mean average mileage rate is Rs. 25-8 per square mile, which is somewhat in excess of that of the previous season, owing to the very small out-turn in Mysore, owing to the difficulties caused by the famine and pestilence there, the high cost of the exploration and survey on the Eastern Frontier in Assam, and the cessation of operations in two divisions where there was nothing left for survey.

Total cost of the season's work.

9. Exclusive of Mysore, which as yet has yielded very little but skeleton triangulation, the average mileage rate is reduced to Rs. 21-12, which is within the ordinary general mean average, and is as low as can be expected for the description of survey employed.

10. Compared with the general results of the previous season, there is an excess of 2,689 square miles of triangulation, while the area topographically delineated is nearly equal (less than one-third of a square mile in defect). In statements A, B and C, in the Appendix, detailed information is given connected with the out-turn of each party, cost, results of the triangulation, and comparison of the out-turn of season 1876-77 with that of the previous season 1875-76.

Comparison of the results of season 1876-77 with season 1875-76.

11. On the whole, the results are very favorable and promising. The separate review of each party will best explain the nature and value of the precise work performed, and the importance to be placed on it.

12. The combined out-turn of Imperial Topographical and Revenue Surveys for the season under review is as given below:

Combined results of the Topographical and Revenue Surveys, for season 1876-77.

	Area in square miles.	Total cost.	General average mileage rate.		Remarks.
		Rs.	Rs.	A.	
Topographical Surveys, ...	18,909	4,81,958*	25	8	*Rs. 3,60,797 paid from Imperial Estimates. Rs. 1,21,161 paid from Provincial Funds, Mysore. Includes also the cost of 22,119 square miles of triangulation in advance of the topography.
Revenue Surveys, 4 inches=1 mile, in Bengal, North-Western Provinces and Punjab.	5,124	2,75,418	50	12	Includes 4 square miles of the Midnapur City Survey.
Topographical (Bombay), 2 inches=1 mile ...	4,072	1,12,377	27	10	
Topographical (Bengal), 1 inch =1 mile ...	1,299	49,280	37	15	
Total ...	29,704	9,19,033	30	15	General average for combined Topographical and Revenue, per square mile.
Cadastral Surveys.					
North-Western Provinces, 16 inches=1 mile ...	738	1,39,898	189	11	or per acre, 4 annas 9 pie.
Bengal, 16 inches=1 mile ...	167	33,869	202	13	Ditto 5 „ 1 „
„ 32 inches=1 mile ...	845	3,01,098	356	7	Ditto 8 „ 11 „
Grand Total ...	31,454	13,93,898			

13. The results of the Revenue Survey alone for the season 1876-77 are:—of Cadastral Survey on 16 and 32 inches to the mile, respectively, 1,749 square miles, at a total cost of Rs. 4,74,865, the average mileage rate being Rs. 271-7; and of Revenue or Village Survey on 4 inches, and Topographical on 2 and 1 inch to the mile, 10,795 square miles, at a cost of Rs. 4,37,075,—the average mileage rate for this combined work being Rs. 40-8.

Revenue Survey results for 1876-77.

14. Complete information in detail, connected with the progress and cost of the Cadastral and other Revenue Surveys, will be found in the separate report which will be submitted, in the usual course, by the Superintendent of Revenue Surveys, it not being ready at present.

15. In continuation of paragraph 27 of the last printed report, the aggregate results of the Topographical and Revenue Surveys of late years are given:—

Combined Topographical and Revenue Survey results up to date.

	Square miles.	Rupees.
Total up to 1876 . .	866,752	2,42,64,417
Add for 1877 . .	31,454	13,93,898
Total .	898,206	2,56,58,315

16. This grand area of 898,206 square miles, which for the most part has been accomplished during my own administration, and forms such a considerable contribution to the first survey of India, does not include the Topographical Surveys executed under the Superintendent, Great Trigonometrical Survey, in the Himalaya Mountains, as well as in Katch and Guzerat of the Bombay Presidency, undertaken there under special circumstances by that branch of the department.

17. On the Index Map of India attached to this report the area above referred to is shewn in green for Topographical Surveys, and red color for Revenue Surveys; whilst the surveys conducted under the separate superintendence of the Trigonometrical Branch are tinted brown. This map shews at a glance what has been effected and what remains to be done.

Index Map of India shewing the progress of Surveys.

18. Under paragraph 16 of my last report, a statement was given to shew how any changes in the constitution, strength, and conditions under which survey parties work, affect the out-turn and mileage rate, and in it the total out-turn and cost since 1866-67, with mileage rates, was shewn. I now purpose to review very briefly the total out-turn and cost of each topographical party during my own tenure of seventeen years (since 1861) of the appointment of Surveyor General, and of Superintendent, Revenue Surveys, for the past 31 years.

Progress and cost of Topographical Surveys since 1861.

Abstract of work performed by Topographical Survey Parties since 1860-61.

Designation of Party.	Total area final topography.	Total area triangulated.	Total cost.	Remarks.
	Sq. Miles.	Sq. Miles.	Rs.	
No. 1 Party, Gwalior and Central India, since season 1860-61.	45,734	52,607	9,69,197	Sanctioned by order of Government, Foreign Department, No. 1975, dated 15th June 1861, to survey the Native states in Central India and Rajputana.
No. 2 Party, Khandesh and Bombay Native States, since season 1860-61.	29,957	39,185	7,29,224	Party organised in 1854 for the Nizam's territory, *vide* Military Department letter No. 521, dated 1st October 1854. Broken up by Home Department letter No. 102, dated 17th May 1870. Reorganised by order of Revenue, Agriculture, and Commerce Department No. 185, dated 6th September 1871.
No. 3 Party, Central Provinces and Vizagapatam Agency, since season 1860-61.	44,572	38,182	9,56,436	Party organised from the old Madras Survey, and placed under the control of the Surveyor General, in 1861, for the survey of Ganjam and Orissa Tributary States.
No. 4 Party, North-Eastern Division, Central Provinces, since season 1860-61.	47,596	47,699	8,42,970	Sanctioned by order of Government, Military Department, No. 543, dated 17th November 1859, for the joint survey of the Orissa States in conjunction with No. 3. Transferred or continued on to the Chota Nagpore Division by Military Department letter No. 725, dated 22nd July 1862.
No. 5 Party, Bhopal and Malwa, since season 1862-63.	34,578	40,419	8,14,930	Sanctioned for the survey of Rewah and Native states in Bundelcund, by Foreign Department No. 271, dated 22nd November 1861. Transferred or continued on to Bhopal and Malwa by Home Department letter No. 513, dated 25th October 1870.
No. 6 Party, Khásiá, Gáro, and Nágá Hills, since season 1863-64.	46,846	38,919	7,53,690	Sanctioned by Home Department order No. 4110, dated 29th December 1863, *vide* Supplement, *Calcutta Gazette*, No. 41, dated 22nd July 1868, for the survey of the hills on the Eastern Frontier, Assam.
No. 7 Party, Rajputana, since season 1865-66.	39,745	44,683	6,14,171	Sanctioned by order of Government, Military Department, No. 771, dated 26th September 1863, for the survey of the Native States in Rajputana.
No. 8 Party, Mysore, since season 1875-76.	1,465	10,862	1,05,022	Sanctioned by Government, Revenue, Agriculture, and Commerce Department No. 683 dated 23rd June 1875, for the survey of the Mysore State.
No. 9 Party, Mysore, since season 1875-76.	861	8,541	97,494	
Since 1860-61, Grand Total ...	291,354	321,097	58,83,134	Average mileage rate Rs. 20-3 per square mile for final topography.

In addition to the above, various special large scale surveys of Military Cantonments, Cities, Forts, and Sanataria have been completed annually, too numerous to detail in this report.

19. Nos. 1 to 4 Parties only were in existence in 1861; No. 5 Party was organised in 1862 for the survey of the Native States in Rewah and Bundelcund; No. 6 in 1863 for the survey of the Khásiá, Gáro, and Nágá Hills, and the Eastern Frontiers of Assam and Bengal; and No. 7 Party for the survey of Rajputana in 1865. The two parties, Nos. 8 and 9, for the survey of the Mysore State, were drafted from the Topographical and Great Trigonometrical Survey only in 1875, and, in consequence of the famine prevailing since throughout the Province, the work has not progressed as it would otherwise have done, and might reasonably have been expected, with old and experienced hands, such as formed these new parties. Taking, therefore, an average for the rest of the original parties (Nos. 1 to 7) during which they have actually been at work, the extensive out-turn of 289,028 square miles in about 15½ years is obtained, at a mean average cost of Rs. 19-10 per square mile, inclusive of the cost of triangulation, which, it will be noticed, is considerably in advance, as it always should be, of the final topography.

20. The work thus accomplished embraces nearly all the Native States of the Central India Agency; about one-half of the Rajputana Agency; the South-west Frontier of Bengal, *viz.*, the Gurjat States and Chota Nagpore District; the

Orissa Tributary States and Khond Mehals; the whole of Bastar, and its tributary States; nearly all the Hill States in the Agencies of Ganjam and Vizagapatam; the Sátpura Hills, and the north-eastern zemindaries in the Central Provinces; the eastern portion of Berar and the Godavery Taluks, and about one-fourth of Khandesh; in Assam, the Khásiá, Gáro, Daphla, and Nágá Hills; on the Eastern Frontier, Hill Tipperah and the Lushai Hills, and part of Bhutan.

Blanks filled in the Map of India since 1860.

21. A reference to any of the old Maps of India will shew that most of the countries above noted have, for the first time, been entered and surveyed; and we now possess accurate geographical information for many ugly and inconvenient blanks, long left unnoticed and untrodden, owing to their peculiar insalubrity, and great difficulty of accomplishment, and which only in 1860 were conspicuous on all our maps; while the cost at which this valuable information towards the accurate delineation of the whole of India was obtained, *viz.*, Rs. 19·10 per square mile, is comparatively very small, taking into consideration the nature of the work performed, and it may be anticipated that such rates are never likely to be realised in future, with all the circumstances of India so greatly changed.

22. The printed reports annually submitted to Government since 1861 will clearly shew the labors of the Imperial Topographical Surveys, and the nature of the work performed in all its details, while the 1-inch and ½-inch standard maps now annually produced by each party and published by the aid of photo-zincography, year by year, sufficiently testify to the various improvements which have been made; and a comparison of the quantity of the work annually placed before the Government, and at the disposal of all departments of the public service, without the loss of a month's time, prove the value of the results as now produced.

Progress and cost of Revenue and Cadastral Surveys since 1845-46.

23. In the Revenue Survey Branch, under my immediate superintendence from 1847 to 1865, and subject to my general control subsequently, up to the present date, the work has been considerably more, embracing a period of 31 years; and, to form a just estimate of all that has been accomplished, a comparison of the results and maps of the present day must be made with those which, from time to time, were issued during the prior period, under the authority of the Board of Revenue, at that time responsible for the conduct of the Revenue Surveys, both in the North-West Provinces and in Lower Bengal.

24. The following abstract shews the total out-turn and cost of Revenue Surveys since 1845-46, and in Appendix I a more detailed statement is given, shewing each division and district completed, date of survey, and area and cost, which it may be useful to place on record:—

	Provinces.	Period.	Area surveyed in square miles.	Total cost.	Average mile rate.			Remarks.
					Rs.	A.	P.	
Scale, 4 miles=1 inch.	Bengal	1845—77	137,209	44,44,153	32	6	2	
	Assam, part of— ...	1849—75	29,159	18,44,004	63	3	9	
	British Burma, part of— ...	1853—70	11,533	3,15,138	27	5	2	Includes some 1-inch Topographical work in Arrakan Hills.
	Oudh	1859—71	24,531	10,97,295	44	11	8	
	North-Western Provinces ...	1848—76	19,915	7,79,448	39	2	3	
	Central Provinces ...	1857—74	50,633	25,92,334	43	7	7	
	Punjab	1846—76	134,255	32,53,785	24	3	9	Includes some 1-inch Topographical work.
	Rajputana, Ajmere, Mhairwara, and Neemuch ...	1847—56	3,841	86,685	22	8	1	
	Sind	1855—70	56,880	8,17,306	14	5	2	Includes a large amount of 1-inch Topographical work.
	Bombay	1871—77	16,337	6,02,618	36	14	2	Scale of survey, 2 inches=1 mile.
	Total ...		493,293	1,58,32,766	32	1	6	
	Cadastral Surveys—	scale, 16 and 32 inches =1 mile.						
	Bengal and Behar ...	1871	1,510	4,49,207	297	7	9	Scale, 32 inches 1 mile.
	North-Western Provinces ...	to	10,718	17,90,858	167	1	5	Scale, 16 inches=1 mile.
	Punjab	1876	53	7,596	143	5	1	
	Total ...		12,281	22,47,661	183	0	3	

25. By the Revenue Surveys on the mouzawar, or village by village, system, scale 4 inches=1 mile, and including some 1-inch topographical work in hilly districts, the total out-turn amounts to 493,293* square miles, at a total cost of Rs. 15,832,766, from which a general average rate of Rs. 32 per square mile is obtained. The Cadastral Surveys, on the scale of 16 inches for the North-West Provinces, and 32 inches to the mile for Orissa and Behar, were commenced in 1871, and up to date 12,281 square miles have been completed, shewing each field or separate allotment, the total cost being Rs. 22,47,661, from which an average rate of Rs. 183 per square mile is obtained; the mileage cost in Behar being Rs. 297-8 for the 32-inch scale, and Rs. 167 and Rs. 143-5 respectively in the North-West Provinces and the Punjab.

* This area includes some 1-inch Topographical work in the Kohistan of Sind, part of the Punjab Frontier, the Arrakan Hills, and the 2-inch work in the Bombay Presidency.

26. For the village or mouzawar survey, scale 4 inches=1 mile, the rates in different provinces vary considerably, according to circumstances. Thus, in Bengal the mean rate is Rs. 32-6; in Oudh, Rs. 44-12; in Assam, Rs. 63-4; North-West Provinces, Rs. 39-2; Central Provinces, Rs. 43-8 per square mile. All the other provinces include a considerable portion of 1-inch topographical work. For the Province of Sind the general average mileage rate is lowest, *viz.*, Rs. 14-5 per square mile; but in it is included a large amount of rough reconnaissance in the Kohistan, and of extremely rapid and partial survey in the open sandy desert of the Eastern and Southern Districts. In Assam the cost was highest, owing to the difficulties of the country, and the excessive rates of labor and carriage.

27. The aggregate out-turn of the combined Topographical and Revenue Surveys during the period above specified is as follows:—

	Square Miles.
Topographical Surveys since 1860-61	291,354
Revenue Surveys since 1845-46, 4-inch by villages and 1-inch Topographical for hills	493,293
Cadastral, 32 inches and 16 inches	12,281
Total Square Miles ...	796,928

or fully one-half of British India, the latest estimated area of which, including Native and Feudatory States, is 1,473,415 square miles (*vide* "Manual of Surveying for India," page 440, 3rd edition, 1875).

28. In placing these remarkable results on record for future reference, I have the satisfaction of looking back on the part I have had the privilege to take in their accomplishment, with just pride. It is not easy for every one to realise the real extent and precise benefit of what has been achieved of late years by this Department, but I leave the records of my office to speak hereafter for themselves, in full confidence that when a fair comparison or review can be instituted with a corresponding period of equal length, the labors of the last 30 years will not shew to disadvantage.

29. The gradual expansion of the Department, and of its sphere of action, year by year, as shewn in the various reports, both in the Topographical and Revenue Survey Branches, are solely due to the pressing requirements of the public service, caused by annexation of territory, and the demands of local Governments or Administrations for resettlements and other objects in British States, and for military purposes in the Native States; and in no instance has any additional work been sought for, or undertaken, except under the most clear and specific orders of the Government of India, on the requisitions of the Civil Officers concerned. In many instances urgent and immediate demands have been made for new surveys, totally irrespective of the departmental means available, and I have been frequently compelled to strain the resources at my disposal, in trained agency, to the utmost, which has caused much anxiety in finding ways and means, for the due and efficient execution of new surveys.

Causes which have led to the expansion of the Department.

30. But, however much the general strength and number of survey parties may have extended during the past quarter of a century, owing to the rapid growth of British territory and British interests in that time, there is the best evidence of a fair and good return for the outlay expended, by the absolute number of square miles of country laid down, and, for all the revenue portion of the work, by the increase of assessment, or other advantages obtained for the great Public Works which have been introduced of late years. Perhaps in no other department of the public service is the money spent so fully and accurately accounted for, by the periodical published history of the results attained, and the definite assignment of the cost to its own particular objects. For every rupee spent there is the equivalent in square miles of country laid down.

Much work still remaining to be done.

31. The completion of the entire first survey of India is a mere question of time and money. It is admittedly a most important object to get this done at the earliest practicable period, and it is not likely to be accomplished at mileage rates below what we have already attained. Therefore the diminution of the trained machinery, by reductions of parties as recently insisted on by the Government at such a critical period of the progress of the great National work on which we have been so long engaged, appears to be as much a mistake financially, as it must be injurious to the crying wants and necessities of the Administrations, which must have the surveys they ask for, sooner or later.

32. What sufficed for mere first assessment purposes at the time of the old settlement in the North-West Provinces, nearly fifty years ago, will not do now, with the material and moral progress of the country advancing in such rapid strides, and the value of the land of so much higher importance in the administration of justice, to meet the legal enactments of the present day. Consequently, not only is the remaining portion of the first general survey yet to be done, but re-surveys of much of that previously executed are called for by competent authorities on larger scales, and in more minute detail and precision, for specific objects now constantly arising.

33. To suppose, therefore, that surveys are no longer required, or that there is not very much to be done in India still, is a fallacy, which it is right should be declared and recorded by those who are most competent, by knowledge and experience of the subject, to speak. It has been repeatedly asked of late,—when the whole of the survey of British India will be completed? But such a question cannot be answered as long as local Governments and Administrations shew good cause for demanding new surveys of provinces and districts, and which are admitted by the Supreme Government. Only within the last two or three years we have been called on to inaugurate new Cadastral Surveys on the largest scales, in both the permanently settled and unsettled districts in the North-West Provinces, in Behar, in Orissa, and in British Burma: and in the three former, such operations are now in full force.

34. If such refinement of large-scale surveys are declared necessary and proper for the permanently settled districts in the North-West Provinces, then precisely the same reasons apply to the whole of Bengal and Behar; and thus, as I have had occasion to report elsewhere, this becomes a very large question indeed, and one which does not portend the end, of the use or necessity of the Survey Department. I believe, therefore, that the present generation cannot possibly foresee any termination for the labors of a skilled department like the one at present employed, and which has been raised and trained with such infinite labor and expense.

35. The Ordnance Survey of the British Isles was commenced long before that of India, and they are still going on with it, and, doubtless, will continue to do so for a very long time to come. This, therefore, may be a fair test for the guidance of those in this country, who may think that the entire survey of a country like India can be accomplished in less time, or that in a country of such diversified character, and such multifarious objects to be attained,

there will not always be found a vast amount of survey work to be cared for, and for which competent machinery must be maintained; for it cannot be had for the asking, or be put down and raised up again at pleasure, without serious financial loss.

Reductions in the Department.

36. The utmost exertions have been, of late, made to bring the Budget Estimates down, lower and lower annually, as required by the Financial Department. Several establishments, both Topographical and Revenue, have been broken up, and the native agency discharged; whilst several Officers and European Assistants have been either allowed to retire on pension, or to go to other Departments, as will appear in the sequel. The precise reductions effected have been fully explained in the letter as per margin,* as well as shewn in the Budget for the ensuing year, just submitted. To attain this object, there has also been an absolute stoppage of all promotions in the Department for the past two years. The effect of such a severe measure is very serious, and detrimental to the real interests of the Government, as well as to the prospects of old and well-tried servants, like those who have so freely sacrificed their health and lives in the arduous and perilous duties necessarily entailed in the survey of this vast country.

* No. $\frac{F}{161}$, dated 16th May 1877, from Surveyor General, to Revenue, Agriculture, and Commerce Department.

37. The estimates, as I have had occasion to point out, have been reduced as low as it is practicable to make them, without further discharge of some of the European element, and the loss of additional working parties. But, to whatever extent the limit of the Survey Budget may be of necessity brought, it is of vital importance that the organisation of the Department should be fixed and admitted according to the reduced authorised numbers of its members, and the promotions carried on in strict accordance therewith, instead of a system of complete blockade, as prevailing at present, which is altogether opposed to the due and proper administration of a large and important Department, if fair results are to be expected, and such progress is to be obtained, as the Annual Reports have now for so many years been successfully recording.

The following table shews the savings from the sanctioned estimates that with the co-operation of the Superintendents of the Trigonometrical and Revenue Surveys) have been effected in the three branches of the Survey Department during the period from 1869-70 to 1875-76:—

Financial Year.	Sanctioned Budget Grant.	Actual Expenditure.	Difference between Budget Grant and Actual Expenditure.	
			Decrease.	Increase.
	Rs.	Rs.	Rs.	Rs.
1869-70	27,08,282	24,58,938	2,49,344	...
1870-71	23,67,273	20,87,103	2,80,170	... ...
1871-72	24,04,710	22,18,409	1,86,301	.....
1872-73	24,56,190	24,10,796	45,394	.....
1873-74	24,15,570	24,55,198	.....	39,628
1874-75	24,15,930	24,35,124	.....	19,194
1875-76	23,81,000	23,38,614	42,386	.....

Cartography-Geographical.

38. In the Appendix statements are given (marked E and F) shewing, in detail, the work completed and in progress in the Geographical, Drawing and Compiling, and Engraving Branches, under the charge of Mr. J. O. N. James,

Assistant Surveyor General. A large amount of very useful work has been accomplished, the details of which could not be referred to here, but the more important compilations and publications are as follows:

INDIA: *scale, 64 miles=1 inch.*—Various additions from recent surveys. Hill features added to the manuscript, either for engraving or lithography, as may hereafter be decided on.

A preliminary edition of this fine map (without hills), with the territorial divisions tinted by chromolithography, was published in January 1877, and has since been in great demand. It is further being utilised for the Geological Map of India, and it is hoped that a second edition, with the hill features added, will soon be ready, to meet the constant requisitions from Government Departments and the public for a reliable map of India on a tangible scale, to provide for which my best efforts for a long course of years have been directed. The hill features are drawn in manuscript, and will be lithographed in chalk, preliminary to being etched on copper, which must take time.

INDIA: *scale, 32 miles=1 inch.*—Additions from recent surveys. Sheets 1 and 4 are in the engraver's hands in outline. Sheet 3, containing Rajputana, Central India, Sind, and part of the Bombay Presidency, is under completion. Sheet 5, Madras Presidency, is nearly ready in outline for the engraver.

BENGAL TRADE MAP: *scale, 16 miles=1 inch,* completed and photozincographed. This map was drawn and published at the request of the Bengal Government to illustrate a report on trade.

BENGAL POSTAL MAP: *scale, 16 miles=1 inch,* based on the map published last year. Under compilation for the Postal Department.

SIND PROVINCE: *scale, 16 miles=1 inch.*—Edition with hills in lithography. Hill drawing completed and published.

CENTRAL PROVINCES, RAJPUTANA AGENCY, CENTRAL INDIA AGENCY: *scale, 16 miles=1 inch.*—These are sister maps to the Provincial ones of Bengal, Punjab, Sind, North-West Provinces, and are all in a forward state, as far as survey results for each have been received.

THE KHANATE OF KELAT OR BALUCHISTAN: *scale, 16 miles=1 inch.*—New edition, with hills. Revised after much labor and enquiry from information received from various sources as quoted on the map, and issued under the approval of the Foreign Department.

COUNTRIES BETWEEN HINDUSTAN AND THE CASPIAN SEA: *scale, 64 miles =1 inch.*—New edition, with hills. Revised and corrected to date, with the approval of the Foreign Department.

INDIAN ATLAS SHEETS for engraving.—The following new manuscript sheets have been taken up and completed in outline and names:—91 N. W. and S. W.; 95 N. W. and 12 N. E. and S. E.: 18 N. W.; 33 S. W.; 36 N. E.; 37 S.E., are in various stages of progress. Large additions have been made from recent surveys to sheets 17 full plate; 22 S. W. and S. E.; 23 N. W.; 33 S. E.; 34 N. E., N. W., S. W.; 35 N. E., S. E.; 36 S. E.; 37 N. E.; 52 N. W., S. W.; 66 and 67 full plates; 71 N. E., S. E.; 74 full plate; 90 S. W.; 92 N. W., S. W.; 93 N. W.; 113 full plate; 124 all four quarters; 125 S. E.; 130 N. W., S. W. Some of these have been completed up to margins and made over to the engravers (*vide* details in Appendix E).

Ganjam and Orissa Survey Sheets completed.

39. Further considerable progress has been made towards the completion of the series of 1-inch standard maps of the old Ganjam and Orissa Survey, referred to in paragraph 41 of last report. Sheets 30, 31, 32, 33, 41, 43, 46, 48, and 52 have been re-drawn in this office and photozincographed. Sheets 62, 63,

64, 65, 66, and 67 are in progress, and the entire series will very shortly be completed, and prove of great value to the local officers.

40. Various other drawings and tracings of maps, plans, and charts have been completed, or are in progress (*vide* Appendix E). No less than 5,271 proofs of maps, charts, and plans have been examined and corrected for press, and 28,738 impressions of maps and plans have been colored during the year.

41. The geographical duties connected with the feeding of the three printing departments, Engraving, Lithographic, and Photographic, are exceedingly heavy, as the details of all the results fully indicate; and this business increases every year. To Mr. James, Assistant Surveyor General, whose zeal and great ability in the discharge of his multifarious duties, connected with so large an establishment, never flags, I am chiefly indebted for the admirable manner in which he manages to meet the great pressure put upon the office, and for the credit which our Geographical publications deservedly enjoy in the estimation of competent persons, both in India and in Europe. The labors of such a Department have, I regret to say, told on Mr. James, whose failing health compelled him to seek a respite from work for three months during the past hot season, and which, I fear, will have to be further extended next year. The special merits of this Assistant Surveyor General are well known in the Department, and to the Government he has served so long and so faithfully. I have the utmost satisfaction in again recording the high sense I entertain of his excellent services, and my earnest hope that he may meet the reward which he has so thoroughly earned.

Mr. J. F. Baness, Chief Draftsman, has rendered good aid. As an old Topographical Surveyor and good Orientalist he has great experience, and is devoted to his work. My acknowledgments are due to Mr. Baness for many years of hard, satisfactory work.

Messrs. Chamarett, Belletty, and Babonau are also entitled to commendation for the satisfactory manner in which they have continued to conduct their respective duties.

A new catalogue or priced list of all available maps and plans has been prepared on the same plan as that issued from the India Office, and the first portion printed, the remainder is shortly expected from the press. The preparation of this catalogue has entailed very considerable labor, and its issue will supply a want long felt.

Copperplate Engraving.

42. In the Copperplate Engraving Branch very great progress has been made during the year, both with the sheets of the Indian Atlas and other general maps: the details of work completed and in progress are given in Appendix F, only the most important work being here referred to.

New Sheets—Indian Atlas—completed and in progress.

* Plates finished with hills.
† Ditto hills engraving.

Indian Atlas plates; sheets 23 S. W.; 52 N. W.; 72 N. W. and N. E.; 93 S. E. and S. W.; 105 S. W.; 124 S. E. and 124 S. W., have been completed and published; nine new sheets in all. The following plates have had large additions from recent surveys: 33 S. E.*; 34 N.E.*; 53 S.E.†; 91 S. E.†; 125 S. E.*; 130 S. W.†; 131 S. W.†

The following new plates of the Indian Atlas are engraving and in various stages of progress: 12 S. E.; 22 S. W. and S. E.; 23 N. W.; 34 N. W. and S. W.; 35 N. E. and S. E.; 36 S. E.; 37 N. E.; 52 S. W.; 72 S. W.; 90 S. W.; 91 N. W. and S. W.; 92 S. W.; 93 N. W.; 95 N. W.; 124 N. W. and N. E.; 125 N. W.; 130 N. W. Many of these are in a fair way towards the completion of outline and writing, and on a few the hills are etching. Heavy

additions have been completed and are in progress on the following old, full-size (double elephant) plates : 17; 31; 73 ; 74; 94 ; 103 ; 106 ; 108 ; 113; 119 and 121. Trifling corrections and additions to date have been made to no less than 70 other quarter plates.

Engraving of general maps.

INDIA.—*Standard map : scale, 32 miles=1 inch.*—Sheets 1 and 4; outlines completed; writing well advanced.

SIND PROVINCE, ASSAM PROVINCE :—*scale, 16 miles=1 inch,* completed and published without hills.

BENGAL BEHAR, AND ORISSA :—*scale, 16 miles=1 inch.*—In two sheets ; outlines completed, writing in progress.

INDIA.—*Skeleton maps, on scales, 80 and 96 miles=1 inch,* to illustrate reports and various projects, as occasion so often requires. Outlines completed, writing just commenced.

Of the series of maps for the "Statistical Account of Bengal," all the maps which were in hand, *viz.*, the Divisions or Commissionerships of Bhagulpur, Patna, Chota Nagpur, and Rajshahi and Kuch Behar, were completed and published, and a large number of each were forwarded to Dr. W. W. Hunter, Director General of Statistics to the Government of India. To illustrate the several volumes of the Statistical Account of Bengal, no less than 18,269 copies of maps have been furnished to Dr. Hunter.

The following statement briefly describes the progress made in engraving the sheets of the *Indian Atlas* since the work was transferred to India, or since January 1869 :—

NEW QUARTER SHEETS completed and published in India	50
NEW QUARTER SHEETS in progress, with details considerably advanced. Eight of these have been published without hills as a preliminary edition.	26
NEW QUARTER SHEETS projected on copper, and borders, &c., cut ...	70
OLD SHEETS (double elephant size) to which extensive additions and corrections from new surveys have been made; names recut; railways, roads, boundaries, &c., added. On five of these the hills have been re-engraved or touched up throughout	18
OLD SHEETS now in progress in various stages	8

Work done in England since 1869.

NEW QUARTER SHEETS completed and published	26
NEW QUARTER SHEETS in progress	5
OLD SHEETS (double elephant size) largely added to	4

Index to the Sheets of the Indian Atlas.

43. Prefaced to this report, a small Index to the Sheets of the Indian Atlas is given, to illustrate the present state of the engraving and publication of these important maps. Since the engraving work was first transferred to India, in December 1868, no less than fifty new quarter plates have been completed, while twenty-six new quarter plates are in progress (some near completion), and eighteen of the old large plates have been revised and completed to date, besides corrections, renewals, and additions to numerous other old plates, which were completely worn out from age before they were sent out from the India Office, and unfit to give impressions, but which it was very desirable and necessary to save by some means, until such time as new materials, from surveys now in progress in the Madras and Bombay Presidencies, and in the North-West

Provinces, could be obtained for the engraving of new sheets or plates based on proper longitudes.

Utility of the Engraving Branch.

44. In addition to the above ordinary Atlas sheets, much useful work has been executed in the shape of the maps of India, the Provincial maps of Bengal, *Behar and Orissa, Assam, Oudh, Sind* and the Punjab, and the Divisional *Gazetteer maps* of Bengal—all of which are in large demand—to illustrate various reports and projects of the Local Governments and other State purposes.

45. The utility of this branch of the Head-Quarters office is annually becoming more apparent, as its work adds permanency to the labors of the Survey Department, and ensures the saving of a vast amount of extraneous labor, which was formerly expended in producing new maps to illustrate special reports, &c.; also in preparing geographical scale district maps, revising the old plates for district and sub-divisional boundaries, railways, roads, canals, &c. The possession of copperplate standards is quite invaluable, obviating the necessity of making fresh drawings on the stone. With the cheap native agency now largely employed, which is daily growing in efficiency, I believe that, under the European aid and supervision now maintained, the progress, quality, and cost of engraving in India will bear favorable comparison with any work of the same kind executed in England; whilst the advantage of the final publication of the Survey of India being conducted under the immediate eye and supervision of the responsible officers in this country, cannot be over-estimated.

46. To Mr. Coard, Superintendent of the Engraving Branch, and his very efficient staff of Europeans, much credit is due for the progress and quality of the work performed, year by year. Mr. Coard's excellent supervision and management of this important work deserves every commendation. The proficiency of many of the native assistants and apprentices is highly creditable to the skill and good management of the Superintendent. Messrs. George G. Palmer and D. Mitchell, hill etchers, and Messrs. Fulford and Tarrant, outline and writing engravers, having completed their full term of five years' approved service, under their engagement with the Indian Government, in November and December 1877, were re-entertained, and allowed an increase to their salaries under the orders of the Revenue, Agriculture, and Commerce Department, No. 368, dated 28th June 1877.

Copperplate printing.

47. In the Copperplate Printing Branch the following work was performed during the year:—

Proofs of maps and atlas sheets	...	...	...	1,129
Transfers from various plates for stone	...	...	...	691
Impressions of maps and atlas sheets	...	...	...	9,687
		TOTAL	...	11,507

48. The services of Mr. H. G. Martin, Plate Printer, will be dispensed with from February next, when his agreement expires, the conditions under which he desired to be re-entertained not having been confirmed. He will be provided with a free passage to London under the terms of his agreement, and his duties will be provided for by one of the copperplate engravers, Mr. Rodgers, who is competent for the duty; the salary of Mr. Martin being thus saved.

Photographic Branch.

49. In the report by Captain J. Waterhouse, Assistant Surveyor General, in charge of the Photographic Branch, details connected with the work of re-pro-

ducing and printing maps by photozincography are given (*vide* Appendix G), and the following is an abstract:—

Abstract of work performed in Surveyor General's Office, Photographic Branch, from 1st October 1876 to 30th September 1877.

	Number of		Prints.							Remarks.
	Sections or sheets.	Negative Plates.	Carbon Prints.	Silver Prints.	Photograph Transfer Prints.	Transfer to Zinc or Stone.	Number of Pulls.	Number of Sheets.	Number of complete copies.	
Topographical Maps	163	281	...	252	249	100	24,523	20,635	20,635	
Revenue Survey Maps	487	555	...	...	522	127	23,460	19,100	19,100	1,420 Anastatic.
District Maps	5	20	...	...	12	4	7,914	6,334	2,997	
General Maps	55	192	...	46	208	57	10,559	7,829	5,291	620 Anastatic.
City and Cantonment Plans ...	30	62	...	66	144	37	5,442	5,442	1,992	
Miscellaneous Maps, &c.	367	475	...	307	528	180	63,531	82,455	79,783	
Zincographic and Anastatic Transfers	...	...	...	...	...	30	.....	.....	.....	
Proofs	...	...	...	...	...	...	5,883	.....	.....	
Cadastral Survey, Bengal	137	...	...	...	...	157	6,854	6,850	3,500	
Photographs of Life-convicts ...	...	...	3,132	...	...	...	.....	.....	.....	
Total ...	1,244	1,585	3,132	671	1,663	672	144,184	148,663	133,318	
Cadastral Survey, North-Western Provinces	2,009	4,334	...	...	4,350	2,021	97,000	97,000	65,900	
Grand Total ...	3,253	5,899	3,132	671	6,013	2,693	241,184	245,663	199,218	

50. The work in this branch is still very greatly increasing with the strong demands for the re-production and publication of the full-scale plans (16 inches) of the Cadastral Surveys of the North-West Provinces, but for which a separate establishment and Budget grant from that Government has been allowed. The urgency of the re-production of the cadastral plans for settlement, irrigation, and water-tax purposes has necessitated much additional pressure on this branch of the Head-Quarters office, intended only to deal with the regular one-inch and smaller scale publications of the Department, but which has been cheerfully met; and Captain Waterhouse's excellent management and zeal, as usual, cannot be too highly praised.

51. Further demands for the cadastral plans of Bengal, Lower Provinces, scale 32 inches, is still pressing; and special arrangements will be necessary to cope with the vast accumulation of executive work of this kind, which it is impossible to deal with, without extensive increased accommodation, establishment, and plant. Every possible assistance has been rendered towards meeting, in some measure, the call for these maps for the Soane irrigation, and the resources of both the photographic as well as the lithographic printing presses have been taxed to the utmost.

52. Attached to Captain Waterhouse's report is a "statement showing the work done for other departments of the public service," which business is greatly on the increase, and demands proper consideration for crediting this office with a fair set-off in the Budget Estimates of the Department. It has always been the object of this Department to comply promptly with the requisitions of other departments for fine or artistic work, which could not be done elsewhere; but, with seriously-reduced Budget Estimates, it is a matter of grave importance that the value of outside work performed should be fully credited.

Lithographic Branch.

53. The Lithographic Branch has, during the past year, accomplished much useful work of a nature not suitable for engraving or photozincography, the details of which are given in the report (Appendix H) by Captain R. V. Riddell, R.E.,

Assistant Surveyor General, in charge. The following abstract shows briefly the nature and extent of the work performed:

Abstract of Drawing and Printing executed at the Surveyor General's Office, Lithographic Branch, from 1st October 1876 to 30th September 1877.

Subject.	No. of Sheets	No. of Copies	No. of Impressions.
District and General Maps, &c.	56	11,789	30,308
Index Maps	11	5,764	11,242
Revenue Survey Sheet Maps; scale, 1 mile =1 inch	23	5,541	5,591
Plans	10	1,375	1,884
Cadastral Maps	132	6,864	6,864
Miscellaneous Drawings	15	4,223	4,425
Forms	50	27,545	27,845
	297	...	...
Maps drawn but not printed	31	...	...
Total ...	328	63,101	88,159
Work done for other Departments.			
Miscellaneous Maps	66	31,495	82,903
Miscellaneous Plans and Sketches, &c.	83	49,728	61,598
Geological Maps	7	5,929	18,215
	156	...	...
Maps drawn but not printed	12	...	...
	168	87,152	162,716
Total of Printing in Lithographic Branch	496	150,253	250,875
Type Branch.			
Departmental orders	27	2,686	3,036
Memoranda and Forms for use of the Department	256	119,922	166,726
Forms for Topographical and Revenue Surveys	49	75,724	218,906
Transfers of Headings, Footnotes, and References to published Maps	3,614	12,493	12,493
Total ...	3,946	210,825	401,161

54. The total number of maps, plans, and diagrams printed amounts to 122,708 copies, which represents 223,030 pulls, or impressions. Of these, no less than 87,152 copies of maps, plans, sketches, and diagrams were for various outside departments. The work in this branch is always of an emergent character, and demands on it from various departments of the public service are incessant. The Lithographic Department is a valuable agency for all ephemeral productions and urgent local wants, preliminary to the preparation and issue of the engraved maps of final surveys, which of necessity take time.

55. The most important lithographic publications during the year are as follows:—

India: *scale, 64 miles=1 inch,* preliminary, without hills.

Territories of the Khan of Kelat or Baluchistan: *scale, 16 miles=1 inch,* with hills, published while this report was passing through the press.

Hindustan to the Caspian Sea: *scale, 64 miles=1 inch,* with hills.

Geological Map of India: *scale, 64 miles=1 inch,* is still in progress, and about two-thirds completed. This map is in four sheets, each bearing from 8 to 10 colors, and of which 1,000 impressions are required, thus entailing about 40,000 printings for a single map. This will probably be ready by March or April 1878, and will be a highly creditable production.

New plan of the Town of Calcutta and Environs: *scale, 6 inches=1 mile,* with numerical and alphabetical Index.

New series of District Maps: *scale, 4 miles=1 inch,* as per margin, obtained by transfers from the copperplates of the sheets of the Atlas of India, with corrected boundaries of districts and internal sub-divisions, and addition of railways, roads, canals, &c., to date, made on the stone.

District Sarun.	District Lucknow.
„ Mozufferpore.	„ Oonao.
„ Durbhanga.	„ Bara Banki.
„ Monghyr.	„ Fyzabad.
„ Puri.	„ Roy Bareilly.
„ Burdwan.	„ Sultanpur.

MAP OF THE PRESIDENCY DIVISION: *scale, 8 miles=1 inch,* re-transfers from very old lithographs.

MAP OF THE DACCA DIVISION: *scale, 8 miles=1 inch.*

MAP OF THE CHITTAGONG DIVISION: *scale, 8 miles=1 inch.*

Work executed for other Departments.

56. For other Departments, 163 maps, plans, diagrams, &c., were completed, from which no less than 87,152 complete copies were printed and supplied.

Color printing still continues to be largely utilised, as far as the competency of the press establishment permits, with great advantage, and tints (engraved on copper) have been especially prepared, to produce gradations in tone or depth of color when transferred to the stone.

57. Captain R. V. Riddell, R.E., in charge of the Lithographic Branch, has been indefatigable in his exertions, and has conducted his duties to my entire satisfaction: he is an officer of considerable departmental experience, and his transfer to head-quarters has been most opportune, as he is able to render good and efficient aid in all the branches, in addition to the special conduct of the Mathematical Instrument Department. Captain Riddell reports favorably of the continued good services of Mr. E. Jevezy, Head Assistant, and Messrs. Lepage and Niven of the Lithographic Department.

Meteorological Observatory.

58. By the order of Government marginally noted,* the Observatory Branch of this office was transferred from the 31st March 1877 to the Meteorological Reporter to the Government of India. One computer has been pensioned, two observers have received gratuities, and one has been transferred to the Engraving Branch, to fill a vacancy caused by the death of a writer.

* Revenue, Agriculture, and Commerce Department No. 129, dated 14th August 1876.

The daily time-ball operations and registering of the maximum and minimum pressures of the standard barometers and thermometers are still conducted in this office under the superintendence of Babu Gopinath Sen and two assistants, and this work will continue to be performed here until such time as the new Observatory at Alipore is completed.

Babu Gopinath Sen, after a service of nearly 38 years, has been granted a superannuation pension, but, by the orders of Government, is directed to continue at his post until such time as the Meteorological Reporter can arrange for the dropping of the time-ball from the new Observatory. Babu Gopinath Sen well deserves every consideration for his long and faithful services.

Office accommodation.

59. The commencement of the erection of the new offices on the ground in Park Street, referred to in paragraphs 65 and 66 of last report, has not yet taken place, nor has a final design been approved of. But the concentration of all the survey offices is a matter of great importance to the efficient working and supervision of different establishments amounting to several hundred persons; and I would urge this strongly for early action. The purchase of the present office, No. 46, Park Street, has been sanctioned, but the conveyance of the property has not as yet, I regret to say, been completed by the Government Solicitor, who has been urged on the subject.

Map issues.

60. During the past year five† despatches of maps, new publications of this office, have been made to the Geographical Department, India Office, London. The following statement shews the total issues of new publications made to various Departments of the State, and to local Map Sale Agents:—

† This includes the despatch of 28th December, which usually goes after 1st January of each year.

	Maps.	Value. Rs.
‡ From Surveyor-General's Office ...	26,939	36,317
Direct from Photographical Branch	5,919	3,808

	Number	Value. Rs.
To Government Officials *bonâ fide* on service‡	32,879	40,125
To the Geographical Department, India Office	4,370	5,878
To local Map Sale Agents ...	5,087	7,676
TOTAL ...	42,336	53,679

61. The correspondence and references connected with the issue and sale of these maps, and the details of accounts for mounting, registering receipts and issues, &c., are exceedingly heavy and troublesome. To convey some idea of the clerical work performed in this office, the following statement is given, extending from 1870 to 1877, which will be useful to place on record:

Correspondence, &c.

Years.	Letters received.	Letters issued.	Total.	Total number of Dockets.	Number of Dák Parcels.	Number of Receipts issued.
1870	3,690	2,811	6,501	26,004	1,427	1,427
1871	3,790	2,685	6,475	25,900	3,846	3,846
1872	3,736	2,893	6,629	26,516	1,937	1,937
1873	3,980	3,245	7,225	28,900	1,622	1,622
1874	3,936	3,086	7,022	28,088	2,009	2,009
1875	3,942	3,629	7,571	30,284	1,183	1,183
1876	3,614	3,246	6,860	27,440	1,269	1,269
1877	3,969	3,101	7,061	28,244	1,270	1,270

62. In continuation of paragraph 73 of the printed report for season 1875-76, the usual Account-current shewing the money transactions connected with map sales is given in Appendix D of this report. The total sum paid into the General Treasury up to the end of December 1877, and for which receipts have been furnished to the Comptroller General, amounts to Rs. 5,670-10-5½, and no money remains in hand. There still remains to be realised from Map Sale Agents Rs. 3,678-6, which on receipt will also be forwarded to the General Treasury.

Map Sale Account.

63. No credit is allowed to this Department for the sale of its productions, which entail a heavy outlay, especially in coloring, mounting, and binding after the maps are struck off,—all of which public officers obtain gratis. Several recommendations have been made on this subject. The time appears to have arrived when the English principle of every official officer purchasing such maps as may be necessary for his purposes, and charging it to his own Budget, should be carried out. With the pressure put on the Survey Estimates, it appears to me something of this sort is very necessary, and it would have the effect of securing more care of public property.

64. With the above and previous expositions of the transactions of the Department for so many years past, my connection with it now ceases. Having obtained Colonel's allowances on the 27th of February last, after a service in India of 44 years, 40 of which have been passed in this Department, the Government of India were pleased to re-appoint me by the orders, as per margin, for the remainder of the current year, and I have now only to record the regret I feel at the separation from the great work I have been engaged on, and from such a body of officers and subordinates with whom it has been my good fortune so long to be associated, and to whom I am so deeply indebted for that cordial co-operation and support, which has alone enabled me to carry on the duties of such a Department. The succession of such a distinguished Officer as Colonel J. T. Walker, C.B., R.E., Superintendent of the Great Trigonometrical Survey, as Surveyor-General from the 1st January 1878, is a matter of the highest gratification to me, as I believe it will be to the Department at large; and my sincere wishes and aspirations will always continue to be for the honor and credit of the Survey Department of India—sentiments which I have circulated in a Departmental Order for the information of all the Members.

Revenue, Agriculture, and Commerce Department No. 323, dated the 23rd May 1877.

65. The review, in detail, of the work performed during the past field season of 1876-77 by the Imperial Topographical Executive Survey parties is as follows:—

EXECUTIVE ESTABLISHMENTS.

No. 1 TOPOGRAPHICAL PARTY.

GWALIOR AND CENTRAL INDIA SURVEY.

66. The programme of this party, as detailed in paragraph 85 of my printed report for the season 1875-76, with a somewhat reduced strength, was, with the exception of triangulation in advance, for which there was no urgent need, fully carried out in a very difficult portion of Central India, along part of the great water-parting of the rivers draining eastwards into the Bay of Bengal, and those which flow into the Gulf of Cambay.

Oodeypore or Meywar, and small detached portions of Gwalior or Sindia's territory, Tonk, and Dungarpur.

67. As it was necessary to make early and special arrangements for a new and improved large-scale survey* of the Fortress of Gwalior, the Cantonments of Morar, and the surrounding country, on the pressing requisition of the Military authorities, and as reported to the Government of India (*vide* correspondence noted in the margin†) the party was divided into two detachments, under the officer in charge and his Assistant; the former, Captain Charles Strahan, R.E., superintending the special large-scale survey, while to Lieutenant Hobday was entrusted the conduct of the ordinary or regular 1-inch work, which lay, for the season, at a considerable distance to the west, in the Native States of Oodeypore, Dungarpur, and Tonk, in the Rajputana Agency, between the parallels of 24° and 24° 45′, and the meridians of 74° and 74° 30′, in the western half of Degree Sheet XII, and about equidistant between the well-known cities of Neemuch and Oodeypore: *vide* Index Map in Appendix.

Strength of Party and Season's Out-turn.

	Topography 1-inch scale.	
Captain Charles Strahan, R.E., Deputy Superintendent, 3rd grade, in charge, ...	36	Also Triangulation and Topography for Gwalior, Morar, and Chitorgarh.
Lieutenant J. R. Hobday, Assistant Superintendent, 3rd grade, ...	192	
Mr. H. J. Bolst, Surveyor, 1st grade, ...	198	
Mr. C. A. R. Scanlan, Assistant Surveyor, 1st grade, ...	...	Employed for the whole season on the large-scale surveys of Gwalior and Morar.
Mr. W. Cornelius, Assistant Surveyor, 2nd grade, ...	205	
Mr. P. J. Doran, Assistant Surveyor, 2nd grade, ...	138	
Mr. C. Templeton, Assistant Surveyor, 3rd grade.	148	
Sub-Surveyor, Joala Pershad, ...	...	Ditto ditto.
„ Abdul Subhan, ...	142	Also large-scale survey of Neemuch.
„ Abdul Gufar, ...	191	
„ Girdharee Lall, ...	194	
„ Abdul Aziz, ...	125	
Total square miles ...	1,568	

In addition, the triangulation for the large-scale survey of Gwalior Fort and City, and Cantonments of Morar was completed, and the detail survey of these places and the Cantonment of Neemuch.

* Fortress of Gwalior, scale 24 inches = 1 mile.
Morar Cantonments, „ 12 „ = 1 „
Country surrounding, „ 6 „ = 1 „

† No. 422 F., dated 14th September 1876.

68. The area for which final and complete topography was obtained on the 1-inch scale is 1,568 square miles, all of most difficult ground, and through nearly all of which close traversing by chain measurements was unavoidable, owing to the dense forest by which it is covered, and the uniform height of all the small parallel ranges of hills running through it.

Final topography completed.

In addition to this work on the 1-inch scale, Captain Charles Strahan, R.E., assisted by Messrs. C. A. R. Scanlan, W. Cornelius, and a Sub-Surveyor, completed the large-scale survey of Gwalior Fortress on a scale of 24 inches to the mile, of Morar Cantonments on 12 inches, and of the Native City, Residency

lands, and surrounding country on 6 inches: for a radius of upwards of 2 miles Captain Strahan, assisted by two Sub-Surveyors, also completed the 12-inch survey of Neemuch Cantonments.

Triangulation.

69. The only triangulation undertaken was, for the large-scale plans of Gwalior, Morar and Chitorgarh. Observations were taken at 15 stations, from which 171 points were fixed.

Opinion on the season's out-turn.

70. Captain Strahan states his perfect confidence in all the season's final topography, which was tested by Lieutenant Hobday and himself in the field by *in situ* examinations, and in the more open portions of country by 32½ linear miles of routes. The total area (1,568 square miles) surveyed on the 1-inch scale, together with the special large-scale surveys of Gwalior, Morar and Neemuch, which entailed considerable time and labor, is a fair season's out-turn; and considering the strength of the party, and difficult nature of the greater portion of the ground, more could not be expected.

Cost of the season's work.

71. The total cost of the season's operations amounts to Rs. 58,632-6. The expenditure has been well controlled by Captain Strahan; and I have every reason to be satisfied with the progress made, the style of the work, and the efficiency of the party.

Description of country surveyed.

72. A most interesting account of the country surveyed, its people, &c., by Captain C. Strahan, R.E., and some notes by Sub-Surveyor Abdul Subhan on the Bheel Clans of Meywar, are given in the Appendix, from which the following leading facts are gleaned.

73. Describing the great water-parting of the rivers which drain to the east into the Bay of Bengal, and those which flow into the Gulf of Cambay on the west, Captain Strahan states:—

"The difference between the two tracts thus divided is most remarkable; the north-east portion being very flat and quite open, with several large towns and villages, and fairly well cultivated: it forms part of the plateau of Rajputana, and is on an average about 1,600 feet above the sea. * * * The change after crossing the water-shed is very abrupt: instead of a fine open, undulating, and almost level country, the whole surface is intersected by water-courses, which gradually become deeper and deeper, at last forming narrow valleys, enclosed by hills, varying from 100 feet up to about 500 feet above them. The fall of the country is very considerable; for the height of the Som river, the lowest point obtained, is 650 feet above sea, showing a drop of 950 feet from the plateau above in a distance of 25 miles, or nearly 40 feet per mile, and again from Bánsi to Dariawad, 17 miles, a fall of 850 feet, or 50 feet per mile." * * *

74. For the first 10 or 12 miles from the summit of the plateau, the hill tops are more or less covered with forest; but further to the south they are far worse, being sheeted over with dense tangled jungle, while the valleys continue to fall, or deepen rapidly, thus greatly increasing the difficulty of traversing the country, and offering no salient points as land-marks to the plane-tablers, as the uniform height of the ranges still continues.

75. The Jákhum, Som and Berach are the only rivers in this part of the country. They are tributaries of the Mahi river, and are not navigable; nor could they be rendered so.

76. There are only two passes in this ground which can be traversed by laden animals: one from Bánsi to Dariawad and on to Bánswára, and the other from Salúmbar to Oodeypur.

77. Teak trees were abundant; but they are cut down young by the Minas and Bheels, and very few large ones are seen. The "Mowah" is plentiful, also the "Tendu," or Ebony. In some parts of these hills the streams are literally poisoned by the abundance of plants of "*Croton tiglium*," or "Jamalgota."

Special survey of the Fortress of Gwalior and Morar Cantonments, &c.

78. The large scale survey of the Fortress of Gwalior, which is now held by the British, scale 24 inches = 1 mile; of Morar Cantonments, scale 12 inches = 1

mile; and of the Residency lands and surrounding country, scale 6 inches = 1 mile, were all most successfully and ably completed; and these valuable plans, which have long been a desideratum, are now photozincographed in excellent style, and supplied to the Military Authorities.

79. As it was essential that these large-scale plans should be thoroughly accurate and reliable in every respect, Captain Charles Strahan was directed to undertake the work himself, with a selected staff from his own party. Very close triangulation was necessary as a basis for the detail survey, and this was completed, first for the Fortress, and subsequently extended over the rest of the ground. Observations were taken at eight stations, from which 171 points were fixed and 61 elevations determined. The total area covered by this large-scale survey is 48 square miles.

80. In the Fort, the highest point is at No. 7 Battery (1,010 feet above sea-level, and 315 feet above the general level of the plains): from this point instrumental contours were run at 5 feet apart within the Fort walls. The extreme length of the Fort is 8,563 feet, and greatest breadth, not including outworks, 2,864 feet; the least breadth is 350 feet. Some useful notes on the Fortress by Mr. C. R. Scanlan, Assistant Surveyor, have been recorded, and will be useful to the Military Department. Much assistance was rendered to the party employed on the Gwalior Survey by Major H. Pearson, of the Quarter Master General's Department.

Good services of the party.

81. Captain Charles Strahan, R.E., has held charge of this party since 1st June 1867, and, under his able and efficient superintendence, the survey has progressed to my entire satisfaction. He is devoted to his duties, full of honorable pride in his profession, and energetic both in the field and recess. His promotion to a higher grade has long been due, owing to the retirement from the service of Major Godwin-Austen; but, under the existing orders of the Government of India, all promotions in the Survey Department have been stopped, the severity of which measure I may express a hope will not be longer perpetuated in the cases of old officers of distinguished merit.

82. Lieutenant J. R. Hobday, Assistant Superintendent, 3rd grade, is a young officer of great ability and promise, and has fully proved his fitness for this Department, where I have every hope he will soon occupy a position of trust and responsibility. He took an active share in the season's field work. Captain Strahan acknowledges his good services; and his talent for drawing is of the first order.

83. Messrs. H. Bolst, C. R. Scanlan, and W. Cornelius are favorably mentioned in the Executive Officer's report, and the two last are strongly recommended for promotion, both for length of service in their present grade and superior qualifications. Mr. Scanlan took a leading part in the survey of the Fortress, City and Residency lands of Gwalior, and Cantonment of Morar, and the Executive Officer reports on his good services in the highest terms. To his excellent judgment and tact in the management of natives is greatly due the success of the large-scale survey of Gwalior and surrounding country. In consequence of the reduction of executive establishments, this Assistant Surveyor has been transferred to head-quarters from 1st November 1877, where his knowledge and experience as a superior draftsman are much required, and can be well utilised.

84. Sub-Surveyor Joala Pershad has also rendered good service in the field, and receives favorable mention in the Executive Officer's report.

Programme for season 1877-78.

85. During the current season the triangulation in advance of details will be extended to the west from the meridian of 73° 30′ through Meywar and Sirohi towards Mount Abu, and the topography completed of the Standard Sheets 83, 84 and 87 in the eastern half of Degree Sheet XIII. This party, since season 1860-61, has completed up to date, or in 16 years, 46,283 square miles of triangulation, and 44,951 square miles of final 1-inch scale topography; also large-scale surveys of all the most important towns, cities, and fortresses

which have fallen within the scope of its operations in the Native States of the Central India and Rajputana Agencies—a task of no ordinary magnitude, some of it in very wild and inhospitable tracts.

86. The extent of work remaining to be done in this division has been estimated in my report cited in the margin at about 14,012 square miles, up to the limits of the Bombay Presidency, and to occupy a period of about seven years; but this will, of course, depend on various local circumstances, which cannot at present be foreseen.

No. 535, dated 13th August 1877.

87. Owing to the reduction in strength of the Mysore Survey Parties, and stoppage of work there, on account of the famine, Lieutenant Hobday, Assistant Superintendent, who had been told off for deputation, continues attached to No. 1 Party; and it is not now considered desirable to transfer his services elsewhere, as, owing to the increasing difficulties of the ground yet remaining for survey, it is absolutely necessary to strengthen this party, so as to secure a fair return for outlay. Mr. J. A. Vanderputt, Surveyor, 2nd grade, and Mr. T. E. M. Claudius, Assistant Surveyor, 1st grade, have been posted to this survey from the dates marginally noted,* in consequence of the abolition of Nos. 3 and 4 Topographical Survey Parties.

Transfers and changes in strength of party.

* 16th November 1877.
1st October 1877.

No. 2 TOPOGRAPHICAL PARTY.

KHANDESH AND BOMBAY NATIVE STATES SURVEY.

88. This party, as usual, worked in two detachments,—one being employed on the ordinary one-inch scale in the Native hilly States north of the Nerbudda, and the second, under the officer in charge, on the more important two-inch survey of the revenue-paying portions of the plains of Khandesh.

In Khandesh, portions of the talukas of Sauda, Chopra, Bhusáwal, Nasirabad, Erandol, Amalner, Shirpur, Shahada, Virdel, Dhulia and Nundurbár. In the Native States, portions of Ali-Rajpur, Chota Udepur, Mathwar, Kathiwara and Barwáni.

Strength of Party and Season's Out-turn.	Triangulation. Square miles.	Topography. 1 in.=1 mile.	Topography. 2 in.=1 mile.	Traversing. Linear miles.
H. Horst, Esq., Assistant Superintendent, 3rd grade, in charge, ...	493	for 2 inch scale.		
Mr. A. J. Wilson, Surveyor, 3rd grade, ...	...	...	87	209
„ A. G. Wyatt, „ 4th „ ...	...	197	19	153
„ F. E. Warde, Assistant Surveyor, 3rd grade, ...	...	138	63	82
„ E. Graham, Assistant Surveyor, 4th grade, ...	145	161	...	269
Sheikh Omar, Sub-Surveyor, ...	...	174	...	253
Mr. F. Rozario, „ ...	...	...	170	...
„ H. M. Holtham, „ ...	...	106	35	90
„ C. George, „ ...	...	...	97	...
Churaman Lall, „ ...	...	111	58	...
Hyder Ally, „ ...	...	143	56	...
Vishnu Moreshwar, „ ...	...	...	141	...
Bapu Jadu, ... „ ...	...	...	85	160
TOTAL ...	638	1,030	811	1,216
Triple junction village marks fixed, in number,		...		... 1,207
Linear miles of check routes, ...		...		... 1,064

89. The season's one-inch work lay in the south-western quarter of Degree Sheet VII (*vide* Index Map in Appendix), chiefly in the Native States of Ali-Rajpur and Chota Udepur, and included a wild and rugged tract from the Vindhya range to the Nerbudda river; while the two-inch survey in Standard Sheets XVIII and XIX extended along both banks of the Tapti river between the meridians of 75° and 76°.

90. The total out-turn of final topography completed covers 1,841 square miles, of which 1,030 square miles were on the standard one-inch scale, and 811 square miles on the scale of two inches to the mile, with village boundaries;

Area of final topography obtained.

1,216 linear miles of traversing with chain and theodolite on the scale of two inches was completed, and 1,207 triple junction village boundary marks accurately fixed. All this work was duly tested by 1,064 linear miles of check routes, and the Executive Officer, Mr. H. Horst, reports very favorably on the accuracy of all the final survey.

Triangulation.

91. A small amount of triangulation, 638 square miles, was also completed, of which 493 square miles were for the large-scale survey of the open revenue-paying portion of district Khandesh, and 145 square miles for the one-inch survey of Native States. Observations were taken at 59 stations, from which 187 points and 113 heights, or one to every five square miles, were fixed.

Cost of the season's operations.

92. The total cost of the season's operations amounts to Rs. 51,242. The work on two inches to the mile cost Rs. 27,343, and the inch survey, Rs. 23,899.

Opinion on the season's out-turn.

93. A description of the country through which the season's operations passed is given in the Appendix. All the country beyond the Nerbudda river, surveyed on the inch scale, in the Native States, was extremely wild and difficult, and presented great obstructions to the progress of the survey; yet, considering this, and the further disadvantage of working, season after season, in two separated tracts and on two different scales, the season's out-turn of 1,030 square miles on the one-inch scale, and 811 square miles on the two-inch scale, of final topography, and 638 square miles of triangulation, is fair. The excessive cost of labor, carriage and feed of elephants, owing to the drought in Khandesh and the neighbouring Native States, has added to the season's expenditure; but the Executive Officer was fully alive to the necessity for economy, and has used his best endeavours to keep down the cost of the survey.

Services of the party.

94. Up to date, since the commencement of this survey in season 1871-72, or during a period of five years, the total out-turn of work amounts to 15,262 square miles of triangulation, and 9,991 square miles of final topography, which speaks well for the zeal and energy of those who have taken part in the work.

95. The Executive Officer, Mr. H. Horst, Assistant Superintendent, 2nd grade, has great experience, having served continuously in the Department for upwards of 23 years, and brings much ability and zeal to bear on the difficult work on which he is engaged. His long, meritorious services deserve every consideration; but the present lamentable state of the Department, I greatly regret, has hitherto precluded my obtaining for him the ordinary promotion, in the room of existing vacancies, of which he is so highly deserving.

96. Messrs. A. J. Wilson, Surveyor, 3rd grade, A. G. Wyatt, Surveyor, 4th grade, F. E. Warde, Assistant Surveyor, 3rd grade, and E. Graham, Assistant Surveyor, 4th grade; also Sub-Surveyors Sheikh Omer and Mr. C. George, have rendered excellent service, both in field and recess. The two latter Assistant Surveyors, who are strongly recommended for promotion by the officer in charge, in whose opinion I fully concur, have more than served the qualifying period.

Programme for season 1877-78.

97. The programme for the next season is as follows: The triangulation in advance will be extended south-westwards, in Degree Sheets VIII and IX, south of the Tapti river; the detail survey, in continuation of the work of previous seasons, will cover the upper half of Degree Sheet VIII, in the Sátpuras, or Standard Sheets 29, 30, 31 and 32, and probably part of 33.

98. The estimated area remaining for survey amounts to 9,000 square miles, of which 6,500 is for the two-inch and 2,500 for the one-inch survey, the approximate time for the completion of which may be stated as seven years under ordinary circumstances and on the late average rate of progress.

99. Sub-Surveyor H. M. Holtham was allowed to resign from the 11th June 1877, and Munshi Churaman Lall was dismissed from the 27th June 1877.

Transfers and changes.

100. On the abolition of No. 3 Party, Messrs. W. F. Pettigrew, Assistant Surveyor, 2nd grade, A. Cooper, Assistant Surveyor, 2nd grade, and G. Vander Beek, Assistant Surveyor, 4th grade, were, from the 11th May 1877, transferred to this party.

No. 3 TOPOGRAPHICAL PARTY.

CENTRAL PROVINCES AND VIZAGAPATAM AGENCY SURVEY.

101. In paragraphs 111 to 113 of the printed report for season 1875-76, it was shewn that this party had only one season's work left, of about 3,150 square miles in the north-west portion of Bastar, conterminous with the Ahíri and other small zemindaries of district Chánda in the Central Provinces, and that, on completion of this blank, the party would be abolished; and it affords me very great satisfaction to report that this has been accomplished, though at the cost of much hardship and suffering to all the members of this party, some of whom were so completely prostrated by jungle fever, that they were with difficulty removed from the field on the conclusion of the work, and are still suffering from the evil effects of malaria in no small degree. The health of the Executive Officer, Captain T. H. Holdich, R.E., Assistant Superintendent, 2nd grade, necessitated his seeking, under medical advice, change of air to Europe, * and he embarked on the 14th May 1877.

Bastar, Native State (north-west portion) of the Central Provinces, Taluks of Parlakot, Partabpur, Narainpur and parts of Dongar and Chota Dongar

Strength of Party and Season's Out-turn.

Captain T. H. Holdich, R.E., Assistant Superintendent, 2nd grade, in charge.

				Final Topography.	
Mr. J. A. May,	Surveyor,	3rd	grade,	... 188	sq. miles and 94 miles routes.
„ F. Adams,	„	3rd	„	... 330	„
„ T. E. M. Claudius,	Asst. Surveyor,	1st	grade,	496	„
„ W. F. Pettigrew,	„	2nd	„	395	„
„ A. Cooper,	„	2nd	„	434	„
„ J. McCay,	„	3rd	„	420	„
„ G. Vander Beek,	„	3rd	„	419	„
„ D. Campbell,	„	4th	„	477	„
„ D. Holman,	Sub-Surveyor,			66	„
	Total square miles			... 3,225	: scale, 2 miles = 1 inch.

* Vide *Gazette of India* Notification, No. 436, dated 11th May 1877.

102. The triangulation for all the portion of country remaining unsurveyed had been completed during the previous season, and the strength of the whole party was therefore devoted to the topography, of which the entire blank portion in Parlakot, Chota Dongar, &c., on the Indrávati river, with a good overlap on the revenue survey of districts Raipur and Chánda, was finished, giving an area of 3,225 square miles, all of the wildest, most difficult, and unhealthy country which this party has had to survey, and in which communication with the several detached plane-tablers was almost impossible. A note by Mr. J. A. May, Surveyor, 3rd grade, descriptive of the country traversed during the season, is given in the Appendix.

Final topography completed.

103. The termination of work in this part of the Central Provinces,—by which the survey of the whole of those Provinces and of the entire division allotted originally to Colonel Saxton's party, as shewn on the index map, and embracing all the Orissa Gurjat States and Vizagapatam Agency, between the parallels of 17¼° and 22½°, or from the Chota Nagpore Frontier to the Godavari river, may now be considered completed,—is a subject for great congratulation to this party and the Department. The large out-turn of final topography obtained, 3,255 miles of such ground on the reduced scale of 2 miles=1 inch,

Opinion on the season's out-turn and cost.

is most creditable to the exertions of all who participated in bringing this last and most arduous season's work to a satisfactory close.

104. The total cost of the season's operations, under all heads, up to the end of the month of May 1877, when it was completely broken up, amounts to Rs. 44,007, to which must be added a further sum of Rs. 3,102, being the pay and allowances of the Surveyors and Assistant Surveyors employed in completing the season's fair mapping, professional reports, computations and returns.

Services of the party.

105. The area completed by this party in the Ganjam and Vizagapatam Agencies of the Madras Presidency, the Orissa Tributary States of Bengal, and the districts of Sambalpur, Raipur and Bilâspur, and their dependencies or zemindaries, with Bastar and its dependencies, amounts to no less than 72,144 square miles. Captain Holdich, R.E., on taking leave of the party prior to his departure for Europe, reported as follows, which is so honorable to all concerned, and so entirely in keeping with the high tone and spirit of zeal and energy which has existed, I am proud to say, up to the present period, in the Department, and I trust nothing may ever interfere to damp or destroy it:—

"The charge of it was made over to Mr. May, the senior Surveyor, who, with Messrs. Adams, Claudius and Campbell, proceeded on their way to Calcutta,—a mere fragment of the well-worn old No. 3 Party, which has worked its way so far, and over such a strange, wild country, almost from its commencement. The rest of it is scattered,—the assistants to other parties, and the native establishment to their homes,—and its career may be finally said to have closed; and in taking leave of it, I must record my high appreciation of that thoroughly good spirit (worthy of the name of *esprit de corps* bequeathed to it by the veteran Surveyor, Colonel G. H. Saxton, who held charge of it so long), which has never permitted one single complaint of hardship, or one single expression of disinclination for most arduous and risky work, to reach my ears during the time which I have had the honor to conduct it."

106. All the records of this survey are now lodged in this office. Messrs. May and Adams have been attached to the Drawing Branch at head-quarters, where they will continue until their services are required in some other executive party; at present their qualifications as draftsmen render them particularly useful at head-quarters, where there is so much mapping work to be done. Their shattered constitutions, also, absolutely demanded respite from active field work for a season. Mr. Claudius has been transferred to No. 1 Party, Gwalior and Central India Survey; Messrs Pettigrew, Cooper and Vander Beek, to No. 2 Party, Khandesh and Bombay Native States Survey; Messrs. McCay and Campbell to No. 6 Party, Khási, Gáro and Nágá Hills Survey.

107. To the excellent management of this party by Captain Holdich, R.E., is chiefly due the successful termination of its labors in this country; and it affords me sincere pleasure to record my appreciation of his professional ability, zeal, energy and sound judgment—qualifications which fit him for a better position than he at present occupies in the Survey Department, and which he has undoubtedly earned. Messrs. May, Adams, Claudius and Campbell receive special mention in Captain Holdich's report. The long, faithful and excellent services rendered by Messrs. May and Adams are worthy of all consideration, and to both of whom my thanks are particularly due for their continued good exertions. The former is a Surveyor of great merit, well up to his work in all respects, and thoroughly reliable. Mr. Adams has just received promotion to Surveyor, 3rd grade, for which he was recommended to the Government in September 1876.

No. 4 TOPOGRAPHICAL PARTY.

NORTH-EAST DIVISION CENTRAL PROVINCES SURVEY.

Portions of the parganas of Rámgarh and Mandla in district Mandla, parganas Bhanpur, Bijagarh, Chauria and Kinhi of district Bálaghát, and Kawarda zemindari of district Bilâspur.

108. This party, reduced to half-strength, for the reasons specified in paragraph 122 of the Administration Report for 1875-76, was conducted into the field by Mr. G. A. McGill, Surveyor, 2nd grade, in consequence of the absence on privilege

leave of Lieutenant-Colonel Depree, and field work was continued in the portions of districts Mandla and Bálaghát, marginally named, in Standard Sheet 36 of Degree Sheet VI and Standard Sheets 33, 34, 35 41 and 42 of Degree Sheet VIII (see Index Map in Appendix), which, with the small forest reserve of Pandratola, was all that remained to be completed in the Central Provinces prior to the abolition of the party; the Chief Commissioner having intimated that he required no other work of a topographical character to be taken up.

Strength of Party and Season's Out-turn.

Lieutenant-Colonel G. C. Depree, Deputy Superintendent, 1st grade, in charge, { Observed at 39 stations, and ran 88 linear miles of test routes, &c.

	Topography. 1-Inch.	4-Inch.
Mr. G. A. McGill, Surveyor, 2nd grade, ...	205	2
„ J. Vanderputt, „ 3rd „	195	...
„ J. H. Wilson, Assistant Surveyor, 3rd grade, ...	185	...
Sub-Surveyor, M. S. Dutt, ...	226	...
„ E. Sharif, ...	214	5½
„ I. Sharif, ...	195	...
Total square miles, ...	1,220	7½

A portion of the boundary between districts Mandla and Bálaghát was also defined, and permanent marks erected along it by Lieutenant-Colonel Depree.

Final topography completed.

109. The total area of final survey completed covers 1,220 square miles on the inch scale, and 7½ square miles (Pandratola forest reserve) on the scale of 4 inches to the mile. This completes all the work which had to be done by this party in the Central Provinces, working up to the limit of the Revenue Survey previously executed in the Jubbulpore, Bhandára, Bálaghát, Raipur and Seoni districts. All the detail survey was carefully tested by the Executive Officer in the field by *in situ* examinations and 88 linear miles of check routes, and Lieutenant-Colonel Depree states that it was all "accurate and good." Lieutenant-Colonel Depree observed at 39 stations to fix points for the Pandratola forest reserve survey, from which 44 points were fixed and 13 elevations determined. Some aneroid heights were also obtained. All the ground surveyed "was hilly, difficult and thinly inhabited: the part to the south contains only about seventeen souls to the square mile."

110. On the completion of all the work in the field, the native field establishment was discharged at Jubbulpore, and the Executive Officer, with the Surveyors and Sub-Surveyors, moved on to recess quarters at Simla, where this old and well-trained party was subsequently absorbed into No. 7 Rajputana Topographical Survey, which required to be strengthened to cope with the enormous area still remaining for survey in the Native States, situated in the north-west and western portions of the Rajputana Agency, and also to deal with the survey of the approaches to Simla from the plains, and the yet more tedious large-scale surveys of the Military Stations south of Simla.

Cost of the season's operations.

111. The total cost of the season's operations, including the cost of completing the season's professional records, fair mapping, &c., amounts to Rs. 44,119, and I am well satisfied with Lieutenant-Colonel Depree's economical management of the party.

Good services of the party.

112. The origin and progress of this party since 1856 can be traced through my several printed Administration Reports submitted to the Government of India, commencing with the report No. 24A., dated 15th April 1853. It has up to date completed no less than 51,805 square miles of triangulation and topography, nearly all of which has been in exceedingly difficult and unhealthy ground, through the entire division of Chota Nagpore, with the Tributary States; Sohágpur of Rewah, Mandla, North Bilaspur and Bálaghát, comprising the north-east portion of the Central Provinces. The Executive Officer, Surveyors, and Assistant Surveyors have suffered much from the evil effects of constant exposure to malaria and the hardships they have constantly endured in the country, the greater portion of which has hitherto been carefully avoided by Europeans. A brief and interesting *resumé* of the labors of No. 4 Topographical Survey Party by Lieutenant-Colonel G. C. Depree, s.c., Deputy Superintendent, 1st grade, is given in the Appendix of this report, to which special attention is directed.

113. It affords me much satisfaction to record my high appreciation of Lieutenant-Colonel Depree's successful labors over a period of 21 years in connection with this Department, and in the highly successful accomplishment of the above very large area of an important and hitherto very unknown tract of country, which it was most desirable to become better acquainted with geographically: his industry, zeal and ability have always been conspicuous, and well deserve the favorable notice of the Government of India. Mr. G. A. McGill, Surveyor, 2nd grade, has again rendered good service: this excellent and able Surveyor has frequently been strongly recommended for the promotion he has so well earned. Mr. Wilson, also favorably mentioned by the Executive Officer, is a very deserving Assistant.

114. This party ceased to exist after the 31st October 1877. Lieutenant-Colonel Depree received charge of No. 7 Party, Rajputana Survey, at Simla, from Lieutenant E. P. Leach, R.E., who obtained furlough to Europe,* and embarked at Bombay on the 26th November 1877. Messrs. McGill and Wilson have been transferred to No. 7 Party, and Mr. J. Vanderputt, Surveyor, 3rd grade, to No. 1 Party, Gwalior and Central India Survey, to equalise the existing establishments.

* *Vide* G.G.O. No. 976, dated 2nd November 1877.

No. 5, TOPOGRAPHICAL PARTY.

BHOPAL AND MALWA SURVEY.

115. On the 25th October 1876 this party resumed work in the Native States marginally named, immediately north of the Nerbudda River. The topography to be taken in hand during the season was entirely in Degree Sheet VI (see Index Map in Appendix), and the triangulation in a small part of Degree Sheet IV, and in the south-west and western portions of Sheets VII and VIII. The programme given in paragraph 131 of the Administration Report for 1875-76 was fully and very successfully carried out, notwithstanding many difficulties caused by heavy forest and malarious fever in the Ghâts, immediately north of the Nerbudda River.

Triangulation through portions of the Subhats of Sháhjahánpur, Amjhera, and Ujjain of Gwalior territory; portions of the Dhár, Dewás, and Silana States, and Indore Subhat of Indore (Holkar's) territory.

Final topography in portions of Dhár and Dewás, in the Subhat of Duraiha in Bhopal; in the Pachmahál (Nimáwar) pargana of Indore territory, and in the Ujjain Subhat of Gwalior territory.

Strength of Party and Season's Out-turn.

	Triangulation. Sq. miles.	Final topography. Sq. miles.	
Captain J. R. Wilmer, S.C., Asst. Supdt., 1st grade, in charge,	680	37	
Lieutenant St. G. C. Gore, R.E., Asst. Supdt., 2nd grade,	2,184	21	
Mr. D. Atkinson, Surveyor, 2nd grade,	...	254	
„ C. F. Hamer, Assistant Surveyor, 1st grade	...	306	
„ E. A. Wainright, „ 2nd „	...	266	
„ H. T. Kitchen, „ 2nd „	...	249	
„ W. H. Lilley, „ 3rd „	...	298	
„ J. E. Murray, „ 4th „	...	310	
„ A. Kitchen, „ 4th „	...	266	
„ G. R. Copping, „ 4th „	...	237	
Sub-Surveyor Prem Raj, ...	...	303	
„ Gobardhan Dass, ...	...	320	
„ Shivcharn, ...	...	101	
Total square miles, ...	2,864	2,968	Includes 83 sq. miles of overlap.

Linear miles of check routes, 344 miles.

116. The area finally surveyed and mapped on the inch scale in Standard Sheets 31 to 36, between Sehore and Indore, including the Pachmahál of Nimáwar Native State, is no less than 2,968 square miles, while the area triangulated in advance of the detail work is equally good, and covers 2,864 square miles. It has been a great object to get the country immediately in the vicinity of Indore and Mhow delineated on various accounts, and this has now been well accomplished. All the final topography was carefully inspected by the Executive Officer, and tested by 344 linear miles of traversing; and Captain Wilmer declares he is well satisfied with the results. Much of the topography, owing

Final topography and triangulation completed.

to heavy forest, could only be obtained by chain and plane-table traversing of which 1,200 linear miles were completed.

117. Of triangulation, 680 square miles were completed by Captain Wilmer, and 2,184 square miles by Lieutenant St. G. C. Gore, R.E. Observations were taken at 59 stations, by which 357 points and 277 elevations were determined.

Cost of the season's operations.

118. The total cost of the season's operations amounts to Rs. 61,067, inclusive of all charges up to the 31st October.

Opinion on the season's work.

119. The work performed by this party during the season is exceedingly good. The party was strong and most efficient, and the result necessarily follows of a large out-turn at moderate cost. I have every reason to be well satisfied with the good exertions of Captain J. R. Wilmer, S.C., Assistant Superintendent, 2nd grade, in charge of the party, and of his Assistant Superintendent, Lieutenant St. G. C. Gore, R.E., R.E., the zealous endeavours of both of whom merit high praise.

120. In the Appendix of this Report, extracts are given from reports by Captain Wilmer and Lieutenant St. G. C. Gore, R.E., descriptive of the country surveyed topographically and triangulated during the season.

Programme for season 1877-78.

121. During the season 1877-78 the topography of all the country in Standard Sheets 22, 23, 24, 25, 41 and 43, in Degree Sheets IV and VII, will, it is expected, be completed. The triangulation in advance of topography will be extended over the north-west portion of Degree Sheet VII, and the south and south-west portions of IX and X, as far west as Partábgarh and Bánswára.

Good services of the party, and work completed up to date.

* Foreign Department letter No. 271, dated 22nd November 1861.

122. This party, organised in 1862 by the orders of the Government of India in the Foreign Department,* for the survey of Rewah and Bundelkhand, on the completion of that work was transferred, in 1871, to Bhopal and Malwa, to deal with all the country north of the Nerbudda River in the Central India and Rajputana Agencies, between the parallels of 22° 15′ and 24° on the east, limited by the boundary of the British District of Saugor (Revenue Survey), and on the west by the Political Agencies of Mahi Kanta and Rewah Kanta under the Bombay Government. Its operations in Rewah and Bundelkhand commenced in October 1862, and its progress since that date has been steady and continuous. Up to date its total out-turn is as follows:—

	Topography. Sq. miles.	Triangulation. Sq. miles.
In Rewah and Bundelkhand, 1862 to 1871,	18,456	23,837
In Bhopal and Malwa up to 1877,	16,098	16,579
Total	34,554	40,416

so that its annual average rate of progress has been about 2,159 square miles of topography and 2,526 square miles of triangulation, which, considering the difficulties experienced in the country south of the Son River, and the disastrous season of 1866-67 (*vide* printed Report to Government, dated 2nd January 1868, paragraphs 123 to 126), the out-turn annually is exceedingly good.

123. The estimated area remaining for survey is 18,738 square miles, which is likely to occupy such a party about eight years more.

124. Captain J. R. Wilmer, S.C., Assistant Superintendent, 2nd grade, who has now held charge of No. 5 Party since 1874, is an officer possessing every qualification for the head of a party, and has during the past three seasons conducted his duties with much zeal and judgment; and it is greatly to be regretted that after so long a service in the department, as eight years, and so highly deserving, he should be still an Assistant Superintendent only. His Assistant, Lieutenant St. G. C. Gore, R.E., Assistant Superintendent, 2nd grade, is most able and efficient; and the good aid rendered by him in the

season's triangulation, through a difficult tract, is cordially acknowledged by Captain Wilmer, and concurred in by myself.

125. Mr. D. Atkinson, Surveyor, 2nd grade, rendered good aid in the field: his plane-tabling was accurate, and the ground well described. Messrs. Hamer and Lilley, seniors of their respective grades, have been promoted to superior grades from 1st April last, by the orders of Government cited in the margin.

No. 702, dated 5th December 1877.

126. The usual valuable assistance was rendered to the party by the Political Agents at Sehore and Indore, for which our acknowledgments are due.

No. 6 TOPOGRAPHICAL PARTY.

KHÁSI, GÁRO AND NÁGÁ HILLS SURVEY.

Boundary survey between the Khási and Gáro Hills districts and district Kámrúp, Assam. Exploratory survey in East Lakhimpur.

127. The desultory and detached nature of the Frontier surveys and explorations on which this party has for several years been employed, again necessitated its being broken into three distinct sections or detachments: Major Badgley, Deputy Superintendent, 3rd grade, in charge, undertook the revisions in Standard Sheets 15 and 16 in the vicinity of Shillong, owing to the great changes and improvements made in that part of the hills (*vide* Index Map in Appendix); Lieutenant R. G. Woodthorpe, R.E., Assistant Superintendent, and Mr. M. J. Ogle, Surveyor, 4th grade, were detached to explore and map that wild and unexamined portion of the Lakhimpur district, south-east of the military out-post of Sadiya, and south of the Brahmaputra river, at the extreme head of the Assam valley, and close to the Burmah Frontier; whilst the other two Assistants were deputed on the Khási, Kámrúp, and Gáro boundary survey. This was the season's programme (*vide* paras. 148 and 149 of my printed report for season 1875-76), and it was carried out as successfully as could be expected with considerable difficulty delay and expense in the low and marshy ground facing the hills, where malarious fever is always endemic.

Strength of Party and Season's Out-turn.

	Topography in square miles.	Triangulation in square miles.	
	2 inches = 1 mile.	1 inch = 1 mile.	
Major W. F. Badgley, Deputy Superintendent, 3rd grade, in charge,	...	369	324
Mr. A. W. Chennell, Assistant Surveyor, 1st grade,	43·3	...	
Mr. W. Robert, Assistant Surveyor, 3rd grade,	116·9	...	
Lakhimpur Explorations.			
Lieutenant R. G. Woodthorpe, R.E., Assistant Superintendent, 2nd grade, in charge, Mr. M. J. Ogle, Surveyor, 4th grade,	717 square miles, ½ inch and 250 linear miles of route surveys		1,722

TOTAL ... On scale 2 inches=1 mile=160·2 square miles.
„ 1 inch =1 mile=369·0 „
„ ½ inch =1 mile=717·0 „

Final topography ... 1,246·2 square miles.

Triangulation, square miles=2,046
Route survey, linear miles = 250

Season's out-turn of final topography.

128. The revisions and additions by Major Badgley, and the boundary work on scales 2 and 1 inch to the mile, give an area of 529 square miles; and the exploration in East Lakhimpur on the ½-inch scale, under Lieutenant Woodthorpe, gives a further area of 717 square miles. Total of final topography obtained on three different scales, equal 1,246 square miles: 250 linear miles of route survey was also accomplished by Lieutenant Woodthorpe and Mr. Ogle.

Triangulation completed.

129. The total area triangulated was 2,046 square miles, of which 328 square miles was for the boundary survey between the Khási, Gáro and Kámrúp districts, by which 189 points were fixed, and the remainder 1,722 square miles were in the Lakhimpur district, by which 39 points and 27 elevations were

determined. The greater portion of the minor triangulation for this special object, through the most intricate ground, was of necessity conducted simultaneously with the detail survey.

Large-scale survey of Shillong.

130. During the recess Major Badgley completed the triangulation for the large scale (24 inches=1 mile) new plan of the station of Shillong, by which 110 points and their elevations were trigonometrically determined, in and around the station: some of the principal roads were also traversed by theodolite and chain with a view to the preparation of the new plan of this Hill Station, which is much needed, and which must occupy some time longer, as it can only be prosecuted according to the pressure of other work.

Cost of the season's operations.

131. The total cost of the season's operations amounts to Rs. 62,858, of which Rs. 29,609 was the cost of the explorations in East Lakhimpur, chiefly caused by the high rates of boat, elephant and coolie hire, essential in such a country.

Opinion on the season's out-turn.

132. The season's actual out-turn of area is small in comparison with the ordinary results of other surveys; but this is consequent on the nature of the duty on which this party was employed. The boundary work alone, on which no area commensurate to cost was obtained, occupied two European surveyors for the whole season; and the detached party in East Lakhimpur was so long delayed, owing to Political considerations, ere orders were issued permitting it to start work, and further, the scope of its operations was so restricted, that in such difficult country, covered with dense forest, swamps, and uninhabited, it was utterly impossible to secure a better out-turn; and it was only by dint of hard labor, under the most depressing influences, such as fever, want of good water and provisions, sores caused by the bites of venomous insects, &c., that Lieutenant Woodthorpe and Mr. Ogle were able to bring in any complete work. Similar difficulties, in a minor degree, were also experienced by the boundary survey party. Work of a detached and desultory nature of this kind must always prove expensive, even under the best management in Assam, with coolie labor at such exorbitant rates of wages. I am of opinion that the officer in charge, Major Badgley, Deputy Superintendent, and Lieutenant Woodthorpe, R.E., Assistant Superintendent, have well and ably conducted the season's operations. In the Appendix is given a report by Lieutenant R. G. Woodthorpe, R.E., on the country explored and mapped by him in East Lakhimpur, which contains some interesting details.

Programme for season 1877-78.

133. The party has again to work in detachments, which, throughout the field season, will be far separated from each other, and it has therefore been found necessary to break or divide it into two small parties to act independently, as communication between them is impossible.

134. The Chief Commissioner having declared that survey operations in Manipur, one-half of which Native State remains for survey on the small scale of $\frac{1}{4}$-inch to the mile, could not be undertaken during the absence of the Political Agent on tour, and that the work on the southern boundary of the Sylhet and Cachar Districts, *viz.*, the survey of the lands which at the time of the first Revenue Survey in 1860-68 were very dense, waste and forest lands, but which are now opened out, and occupied by tea plantations and rice cultivation, is of the utmost importance and far more necessary than any other work, the main detachment,* under Major W. F. Badgley, Deputy Superintendent, has commenced this work in South Sylhet and Cachar, and is also carrying out the completion of the revisions and additions on the 1-inch scale in Standard Sheet 14 (*vide* Index Map in Appendix).

* Major Badgley.
Mr. J. McCay.
Mr. D. Campbell.

North Assam Frontier exploration.

135. The second detachment, under Lieutenant R. G. Woodthorpe, R.E., Assistant Superintendent, 2nd grade, assisted by Mr. W. Robert, in concert with

Lieutenant H. J. Harman, R.E., Assistant Superintendent, officiating 2nd grade, Great Trigonometrical Survey, who has been employed on the main Triangulation up the Brahmaputra River, and whose work has consequently come into close contact with that of the Topographical Survey of this important part of the Frontier, will explore, triangulate and map the country on the north-east of the Lakhimpur District, in the vicinity of the Subansiri River, and also subsequently between the Dibang River and Brahmakund, as sanctioned by the Government of India, Foreign Department, memorandum No. 2334, dated 9th October 1877.

136. This expedition will, it is confidently hoped, add materially to our knowledge of the northern Frontier of Assam, or of some portion of that *terra incognita* between the Frontiers of Assam and Thibet which has on three occasions been so successfully entered by Major H. H. Godwin-Austen, Deputy Superintendent, Topographical Survey: first, in 1863, with the Bhutan Mission when he completed the survey of the greater portion of western Bhutan; in 1864, when he surveyed and mapped 2,000 square miles of the Bhutan Duars and accompanied the Military expedition against Bhutan; and in 1874-75, when assisted by Lieutenant Harman, of the Great Trigonometrical Survey, and Mr. M. J. Ogle, Topographical Survey Department, he mapped 2,375 square miles of the Daphla hills, and was the first to define, with tolerable accuracy, the course of the Subansiri River and its probable proximity to the Sanpu or Yaru of Thibet, as sketched on the Provincial Map of Assam from the Pundit's Route and lately published (1875) by this office.

The Subansiri River and probable course of the great Sanpu.

137. In connection with the subject of these geographical explorations, it is interesting to note that the question of the course of the great river of Thibet, the Nari Chu, Sangpu, or Brahmaputra, and its channel through the hills into the valley of Assam, which has so long been a subject of keen discussion between European geographers, and which was so ably treated by Captain Wilcox in the Asiatic Researches, Vol. XVII, is likely to be revived. Major Godwin-Austen writes as follows regarding the great valley which he saw about longitude 70°, and the course of the Subansiri River and its branches, as shewn on his map of the Daphla hills, published in October 1875 and in the engraved Map of Assam, compiled in 1875, and published by this office in 1877: "It is not a probable course at all, but an *actual course*. I really think we are right. My branch of the Subansiri that joins the Pundit's Sikung River is perfectly accurate: that branch I know well, and saw well, and it is within 2 to 3 miles of its position all along, and in some places, I will be bound to say, exact. I am also sure of the great valley north and south, near longitude 94°. How well, again, the Dhirang Chu of the Pundit joins my Borowli and its tributaries.*"

* Lieutenant H. J. Harman, R.E., of the Great Trigonometrical Survey, has also lately collected some valuable information in connection with this subject.

138. Major Godwin-Austen is of opinion that the eastern branch of the Subansiri River, near longitude 94°, will prove to be the great river of Thibet, which hitherto has been supposed to enter Assam north-west of Sadiya through the Dihang River. This question might perhaps have been placed beyond doubt, had Major Godwin-Austen been allowed permission, as so often and so earnestly solicited, to continue his explorations in 1875: *vide* para. 150 of the printed report for season 1874-75. This valuable officer, during the year under review, has retired from the service from the 12th June 1877, and this able and accomplished surveyor and explorer is, I much regret, now lost to the Department. Major Godwin-Austen's good services in the Kashmir and Ladak Survey, and subsequently in Bhutan, Manipur and along the Eastern Frontier and Assam, have frequently been brought to the notice of Government in the printed reports of the Survey Department,† and in the special reports submitted from time to time forwarding the results of his labors. It affords me great gratification thus to place my appreciation of his merits on record, in taking leave of him after so long a connection.

† See printed reports of the Great Trigonometrical Survey and Topographical Surveys since 1861.

Good services of the party.

139. Since season 1863-64 this party has rendered 38,243 square miles of very intricate and difficult topography, on scales varying from 2-inches to ¼-inch to the mile, according to the locality and nature of the ground in which it has been employed, and which has varied considerably along the Eastern Frontier of Bengal, and the hills and plains of Assam, the Nágá and Lushai hills, Manipur, and the Burman Frontier. Major W. F. Badgley, Deputy Superintendent, officiating 3rd grade, is an excellent Frontier surveyor and explorer, gifted with powers of endurance, and most able in his field duties. Lieutenant R. G. Woodthorpe, R.E., Assistant Superintendent, 2nd grade, who now for the third time has been specially selected for survey expeditions beyond the British Frontier, is a young Engineer Officer of great talent and energy, with superior qualifications as a draftsman, and has been most successful in his intercourse with the wild tribes on the Frontiers of Assam. My cordial acknowledgments are due to this officer for much praiseworthy work, obtained under circumstances of considerable risk to health, and even life.

140. Mr. M. J. Ogle, Surveyor, 4th grade, and Mr. A. W. Chennell, Assistant Surveyor, 1st grade, are both very deservedly commended by the officer in charge for the good services they always render, both in the field and recess duties. They have, in consequence of bad health, brought on from constant hard-work on the Frontier, obtained furlough to Europe for a year, and, it is hoped, will return in renovated health to renew their labors, as the knowledge and experience they have gained is of great value on a wild Frontier survey.

141. In the interests of the local Administration, and to complete our better geographical knowledge of the entire Frontiers of Assam and the country around it, it is of the utmost importance that the explorations undertaken of late years by this party, by order of Government, should be continued and urged forward effectively and vigorously to completion, as we have still much to learn of the Frontier round the head of the Brahmaputra River, its people, and the routes between Assam, China and Burma; and without this, the survey of the Assam Province cannot be considered completed.

142. It is difficult to estimate the precise area which may yet have to be brought within survey or reconnaissance operations, or, in fact, to predict how far our explorers may have to advance in any direction round the North-East Frontier. A general rough approximate area of about 13,704 square miles was lately estimated under this head, and the probable time for completion about 3 years. This, however, is a mere assumption as to the probable area, including Manipur, likely to be examined, and what may be constituted the "outer line" of British boundary. The probability of completing all this will likewise depend on the nature and scale of the exploration, as well as on the Political and Physical difficulties met with.

143. With the above exception, the whole of the Province of Assam, both hills and plains, has been completed by the joint efforts of the Topographical and Revenue Branches of the Department, after much labor, anxiety and its consequences. Excellent maps, of all descriptions and on various scales, have been published for the use of the local Administration, and the conclusion of a work of such magnitude is a matter of the highest congratulation.

No. 7 TOPOGRAPHICAL PARTY.

RAJPUTANA AND SIMLA SURVEY.

Portions of the Native States of Bickaneer, Shekawati and Jodhpore, in the Rajputana States.

144. In consequence of the late period at which the orders of Government for the large-scale survey (100 feet = 1-inch, with contours at vertical intervals of

10 feet) of the Observatory Hill, Simla, were received, the officer in charge of the party; Lieutenant E. P. Leach, R.E., Assistant Superintendent, 2nd grade, was detained with a party of Sub-Surveyors at Simla up to the end of December. The senior Surveyor Mr. R. Todd, was deputed accordingly to proceed with the main portion of the party into the Native States of Jodhpore and Bickaneer, to carry out the programme for the field season, described in paragraphs 169 to 171 of the printed report for 1875-76.

Strength of Party and Season's Out-turn.	Triangulation in advance of Topography	Final Topography. Inch scale.	Large scale.	Remarks.
	Sq. miles.	Sq. miles.	Sq. acres.	
Lieutenant E. P. Leach, R.E., Assistant Superintendent, 2nd grade, in charge,	900	...	74	Simla Observatory Hill contour survey, 200 feet = 1 inch
			8,000	Jodhpur City plan, 6 inches = 1 mile.
Mr. R. Todd, Assistant Surveyor, 1st grade, ...	3,687*	...	...	
,, C. Tassell, ,, ,, 1st ,, ...	2,590	145	...	
,, W. Kelly, ,, ,, 4th ,, ...	...	1,060	...	
Sub-Surveyor Harlal Sing, ...	...	431	...	
,, Kalka Pershad, ...	...	798	...	
,, J. Nathaniel, ...	...	762	...	
,, Sher Singh, ...	...	742	...	
,, Atma Sing, ...	...	557	...	
TOTAL ...	6,977	4,495	8,074	

Fifty linear miles of forest reserve boundaries traversed and mapped

* Also, during the recess, 120 square miles of triangulation for the Simla approaches survey.

145. The elaborate contoured survey of the Observatory Hill was completed by Lieutenant Leach, R.E., most ably and expeditiously, and copies of the plan on the scales of 100 and 200 feet to the inch were printed and furnished to the Secretary to Government, Public Works Department, by the end of January 1877, for which the thanks of the Government of India* were accorded to Lieutenant Leach, who joined his party in Rajputana, near Ajmere, and prosecuted the field operations there by the middle of the same month.

Completion of the Observatory Hill Estate Survey, Simla

* Government of India, Public Works Department, No 41M., dated the 8th February 1877.

146. In the Native States of Marwar (Jodhpore), Shekawati and Bickaneer, in which the detail survey was conducted, an area of 4,495 square miles on the reduced scale of 2 miles to the inch was completed in Degree Sheets XI and XII (*vide* Index Map in Appendix). This reduction of scale in the desert portions of the Rajputana States received the approval and sanction of Government (*vide* paragraph 171 of the printed report for season 1875-76); and the measure has, I am glad to report, proved most successful, as the reduced scale not only admits of rapid progress, but is more than sufficient for the extreme desert and open nature of the ground, and the amount of details required. All the season's plane-tabling was duly tested in the field, and the Executive Officer states that he is well satisfied with its accuracy and completeness. In the southern and south-western portion of the country allotted to this party, there still remains some richly cultivated and thickly populated land, which will require to be dealt with on the 1-inch scale.

Season's out-turn.—Final topography.

147. The total area of triangulation completed in advance of topography covers 6,977 square miles. Observations were taken at 59 stations, from which 515 points were fixed, and 407 elevations were trigonometrically determined, which gives one trigonometrical point for every 13·6 square miles and 1 elevation for every 17·1 square miles of ground, which, for the reduced scale of survey, is more than sufficient in a desert country, where only very small sand-hills and ridges, without any other feature, exist.

Triangulation completed in advance of details.

148. In addition to the above, the usual survey (6 inches=1 mile) of the City and Environs of Jodhpore was completed, and 50 linear miles of forest reserve boundaries in Ajmere and Mhairwara were surveyed and mapped, at the urgent request of the Civil Authorities.

Plan of Jodhpore City and forest reserve boundaries.

149. On the return of the party to recess quarters, the triangulation for the survey of the approaches to Simla, and of the several Military Cantonments between Simla and the plains, was taken in hand, and carried over 120 square miles. This important undertaking, the want of which has long been greatly felt, will be prosecuted now to completion, as weather and the other objects will permit: other minor local surveys, for the urgent wants of the Government and of the Municipality, were also performed.

Simla Approaches, survey.

150. The total work accomplished by this party, *viz.*, 4,495 square miles of final topography on the $\frac{1}{2}$-inch scale, 8,074 acres of large-scale survey (Observatory Hill contoured survey and Jodhpore City and Environs), and 6,977 square miles of triangulation, with 50 linear miles of forest boundaries, and 120 square miles of triangulation in the hills south of Simla, is an excellent season's work; and much additional anxiety and labour was imposed on Lieutenant E. P. Leach, R.E., Assistant Superintendent, both in the field and recess, in carrying out the details for so successful a season's out-turn, and completing all the computations, professional records, and season's fair mapping, including a revised series of the Standard skeleton Sheets of the Simla Survey, to show more clearly the estate boundaries, as revised and supplemented by the Deputy Commissioner, which will be published in due course.

Opinion on the season's out-turn.

151. A description of the country triangulated and surveyed in detail, with notes on the most important towns visited during the season's operations, by Lieutenant Leach, is given in the Appendix of this Report. Lieutenant Leach acknowledges with thanks the cordial co-operation and assistance he has at all times received from the Political Agents of Marwar and Bickaneer, Major Walter and Captain Burton.

152. In consequence of the drought in the northern portions of Rajputana, and the representations made by the Political Officers, who anticipated great scarcity of fodder for cattle, it has been deemed expedient to divert the regular course of the field season's operations temporarily into the better-watered and more fertile country west of Erinpura, in Degree Sheet XXI, between latitude 25° and 26° and longitude 72° and 73°, instead of allowing the work to proceed northwards into the Bickaneer desert. This unavoidable measure will, in some measure, affect the season's out-turn, first, as there is no triangulation available for that part, and next, because the scale of survey must again be maintained on the standard of 1 mile to the inch, to suit the nature of the ground in that locality.

Programme for season 1877-78.

153. The party has therefore been broken into three detachments: the first, under the officer in charge, to operate in the ground between Simla and the plains, as well as the Cantonments of Kasauli and Subáthu, urgently called for by the Military Authorities, until the triangulation in Degree Sheet XXI is sufficiently advanced for starting more hands on the details; the second, under the senior Surveyor, to triangulate in Degree Sheet XXI; and the third, to complete the southern half of Degree Sheet XII in Marwar or Jodhpore territory. No better disposition of the party could be made under the circumstances.

154. In the review of the work of No. 4 Party, which, under the orders of Government, has now been broken up and absorbed into No. 7 Topographical Party, it was stated that Lieutenant-Colonel Depree, Deputy Superintendent, 1st grade, had, from the 1st October 1877, received charge of this party from Lieutenant E. P. Leach, R.E., who, on the termination of the recess and satisfactory completion of all his work, proceeded on furlough on the 26th of November 1877.*

Changes and transfers.

**Vide* G. O. No. 976, dated 2nd November 1877.

155. Lieutenant E. P. Leach, R.E., held charge of No. 7 Party for the past three years, and I cannot too highly commend the zeal and energy of this talented officer, who, on all occasions, has taken a very leading share in every duty

performed under his superintendence, and maintains efficiency in the highest degree. The fair hill drawing of the map of the Simla Extension Survey, as well as of the City of Jodhpore by this officer, is of a very superior order, and most creditable to his industry and speciality in this important line of a surveyor's profession.

156. The party, as now re-modelled by the junction of the two establishments is shewn in the margin; and I have every reason to believe that, under the able management of Lieutenant-Colonel Depree, it will continue to render as good service as it has done since its formation in 1874. The native agency of sub-surveyors of both parties has been retained, to deal particularly with the easy open ground in Rajputana, for which they are well qualified.

Lieutenant-Colonel G. C. Depree, Deputy Superintendent, 1st grade, in charge.
Lieutenant E. P. Leach, R.E., Assistant Superintendent, 2nd grade, on furlough.
Mr. G. McGill, Surveyor, 2nd grade.
" E. S. P Atkinson, Surveyor, 4th grade (returned from furlough, 14th November 1877).
" R. Todd, Assistant Surveyor 1st grade.
" J. H. Wilson, " 3rd "
Sub-Surveyor, Babu Madhusudan Dutt.
" Mr. John Noah.
" Munshi Yusuf Sharif.
" " Imam Sharif.
" " Kalka Pershad.
" Mr. James Nathaniel.
" Munshi Hussain Baksh.
" " Sher Shah.
" " Atma Singh.

Transfers.

Mr. J. A. Vanderputt, Surveyor, 3rd grade, to No. 1 Party.
" C. Tapsell, Assistant Surveyor, 1st " to " 1 "
" W. M. Kelly, " to Forest Department.
Babu Hurlal Singh, Sub-Surveyor, to No. 5 Party.

157. The area still remaining in its allotted field of work is very large—48,092 square miles; but a considerable portion of this area is open, sandy desert, which can easily and rapidly be surveyed on the half-inch scale, with the aid of which reduction possibly the entire agency may be completed in about twelve years. The Index Map shows the whole of the western portion of Rajputana, Bickaneer, Jeysalmere, Malwa (Balmir), up to the Sind and Bhawulpore Frontier, and part of Jodhpore, as remaining for survey.

158. Since 1864 this party, originally raised by Captain Geo. Strahan, R.E., has completed 47,885 square miles of triangulation, and 39,349 square miles of final topography; also the large scale-surveys of ten cities and cantonments, including the important 24-inch scale survey with Estate boundaries of Simla and Jutogh, the contoured survey of the Observatory Government estate, scale 100 feet to the inch, and the partially-contoured survey of the Simla eastern extension to the Mahásu Range for the Water-works project, on 6 inches to the mile.

159. Mr. W. M. Kelly has been selected for a superior appointment in the Forest Department, for which he is well qualified and highly deserving. In consequence of the lamentable prospects for highly qualified and well-trained European agency in the Survey Department, owing to the chronic state of reductions enforced of late years, I have had great satisfaction in recommending Mr. Kelly for that well-deserved promotion, which could not be obtained for him here. I have considered it a duty under such circumstances to assist the subordinates of this Department, as far as practicable, in obtaining other situations to better their positions; but it is at the expense of the real interest and efficiency of this Department, in which the training of candidates or probationers is a most serious and expensive matter: unless young hands both in the senior and junior executive branches are constantly maintained, and trained up in all their duties, it is impossible for any Department to be in a position to meet the calls made on it.

No. 8, TOPOGRAPHICAL PARTY.

NUNDYDROOG DIVISION MYSORE SURVEY.

Portions of the districts of Bangalore, Túmkúr, Mysore and Kolar.

160. In my letter No. 163F., dated 21st May 1877, I especially reported the diffi-

culties under which the Mysore Topographical Survey labored in consequence of the famine and drought, which during the past season has prevailed nearly throughout the southern peninsula. Very little of the Mysore country which had been triangulated and prepared for detail survey could be entered, and it was therefore impossible for the party to carry on its work in a compact block or continuously, as so desirable. In consultation with the local authorities, certain tracts were selected in which it was comparatively easier to obtain water, provisions and forage; and although no more triangulation in advance was absolutely required, it was deemed expedient to employ several of the surveyors on this duty over new ground, so as to ease the bad parts of the country of any continuous strain for any length of time, in any one part, for water, carriage and food-supplies. No definite programme could, therefore, be attempted under these unfortunate circumstances; but care was taken to utilise the establishment, and to keep it in full employment, in some way or other, in whatever ground it was possible for the surveyors to enter and work.

Strength of Party and Season's out-turn.	Triangulation. Sq. miles.	Topography Sq. miles.
Captain G. Strahan, R.E., Deputy Supdt., 2nd grade, in charge	5,280 square miles of triangulation by Captain Geo. Strahan, Messrs. Chew and McNair; 35 miles of traversing by Messrs. White and Flemming.	...
Mr. R. W. Chew, Surveyor, 2nd grade, ...		...
„ R. D. Farrel, „ 4th „ ...		136
„ I. J. James, Assistant Surveyor, 1st grade, ...		210
„ F. Kitchen, „ „ ...		280
„ W. Stotesbury, „ „ ...		352
„ J. A. Barker, „ 2nd grade, ...		166
„ W. McNair, „ „ ...		..
„ P. White, „ 4th grade, ...		22 *
„ G. L. Flemming, „ „ ...		26 *
„ G. A Knight, „ „ ...		273
and six Sub-Surveyors, all under training ... ... Recording, traversing, &c....		...
Total square miles ...	5,280	1,465

In addition to the above, nine stations were observed at, embracing an area of 527 square miles, but the work could not be completed, and 1,440 square miles were reconnoitred and prepared for triangulation.

* On 4-inch = 1 mile.

Final topography completed.

161. The total area of final topography completed covers 1,465 square miles, of which 48 square miles, or the Bilikal forest reserve, was surveyed on the larger scale of 4-inches to the mile, and the rest, or 1,417 square miles, on the standard scale of 1-inch to the mile, in the districts of Bangalore, Túmkúr, &c., of the Nundydroog Division.

Triangulation, &c.

162. The season's triangulation in advance of details covers 5,280 square miles. Observations were taken at 95 stations, from which 770 points were fixed and 555 elevations were trigonometrically determined, 35 linear miles of close traversing on the 4-inch scale for the Forest survey and about 1,440 square miles of rough reconnoissance were also completed in the Túmkúr and Kolar districts.

Opinion of the season's out-turn.

163. For a short field season, during which the Surveyors were repeatedly stopped by cholera, famine and want of water, and the difficulties caused by the desertion of lascars and signallers, or carriers, the out-turn of work, *viz.*, 1,465 square miles of topography and 5,280 square miles of triangulation, is as much as could reasonably be expected; and it is most creditable to the party that it maintained its ground under such trying circumstances as the exceedingly unfavorable nature of the situation permitted, and was able to complete any work at all.

Cost of season's operations.

164. The total cost under all heads for the season's work amounts to Rs. 56,776, which is considerably below the anticipated amount. Great efforts were made to curtail expenditure in every possible way, and the transfer of the Assistant Superintendent, Lieutenant Hobday, estimated for and intended for this survey, was not carried out. A further and yet larger saving was also effected, when, at the close of the field season, Captain Geo. Strahan, R.E., in charge, obtained furlough† to Europe, and was relieved by Captain J. R. McCullagh, R.E.,

† Sanctioned by G. G. O. No. 382, dated 27th April 1877.

Assistant Superintendent, attached to No. 9 Party, on the 26th of April 1877; and subsequently, when this latter officer also obtained furlough* at the close of the recess, and left India on the 5th November 1877, the remaining of the two parties, Nos. 8 and 9 (all not deputed to famine duty), were amalgamated, and placed under the charge of a single Deputy Superintendent (Major H. R. Thuillier, R.E.); so that, instead of four Executives and Assistants, which is the ordinary complement for two full parties, there is but at present a single one, and the salaries of these have thus been saved to the Mysore State.

* Sanctioned by G. G. O. No. 912, dated 9th October 1877.

Changes in the executive superintendence.

165. This, though undoubtedly the most economical arrangement for the Mysore State, is not without considerable danger to the interests and future prospects of the Survey, as a single officer only, admits of no relief or protection against contingencies of any sort; and should his health fail, there is no responsible officer anywhere near at hand, to take up his duties, or conduct the ordinary routine of the survey. A second officer, or Assistant Superintendent, will therefore, be found essential to be posted during the ensuing financial year.

166. No definite programme for the ensuing field season of 1877-78 can be given just now, as the country still labors under the difficulties caused by the famine and drought of the past two seasons. Measures have been adopted, under the advice and orders of the Chief Commissioner, to place at the disposal of the Public Works Department, for employment on local and famine relief works, every Assistant Surveyor and Sub-Surveyor whose services can possibly be spared; and nine Surveyors and Assistant Surveyors, as detailed in the margin, have thus been transferred temporarily, while one has been sent back temporarily to the Great Trigonometrical Survey,† where he was urgently required, and one has been allowed furlough in India from 1st August 1877.‡

Programme for season 1877-78.

On Famine Works.

Mr. R. D. Farrell, Surveyor, 4th grade, from 1st November 1877.
„ L. J. Pocock, „ 4th „ „ „ „ „
„ F. Kitchen, Assistant Surveyor, 1st grade, 1st November 1877.
„ J. A. Barker, „ 2nd „ „ „
„ W. Oldham, „ 3rd „ 1st September „
„ P. White, „ 4th „ 1st October „
„ G. L. Flemming, „ 4th „ 1st September „
„ G. A. Knight, „ 4th „ „ „
„ J. M. Kennedy „ 4th „ „ „
† „ T. Kinney, „ 1st „ transferred to the G. T. Survey.
‡ „ J. W. Macdougall, on furlough in India, from 1st August 1877.

167. Thus reducing the survey establishment temporarily for the current season's work to the strength marginally noted, which is less than an ordinary party, as originally estimated for. The importance of squaring up and completing the detail work of the several sections of the past season is very essential, so as to secure the result on which both money and labor have been bestowed.

Major H. R. Thuillier, R.E., Deputy Superintendent, 1st grade.
Mr. R. W. Chew, Surveyor, 2nd grade.
„ H. Keelan, „ 3rd „
„ A. James, Assistant Surveyor, 1st grade.
„ W. Stotesbury, „ 1st „
„ H. Todd, „ 1st „
„ W. W. McNair, „ 2nd grade, and six Sub-Surveyors.

168. Under the recent orders of the Government of India, as per margin, it has been ruled, on the suggestion of the Chief Commissioner, that only one party is to be employed for the next year or two in Mysore, pending the recovery of the finances from the severe effects of the famine. On the return, therefore, of the several Surveyors and Assistants, as above mentioned, from the famine duty on which they are engaged, such number of them as will not be required to make up a full and efficient party under Major Thuillier are to be provided for elsewhere.

No. 765, dated the 21st December 1877.

169. This will involve the re-transfer to the imperial estimates of six out of the nine surveyors or assistants now on famine duty, and will form

of necessity an extra charge in the Departmental Imperial Budget. This transaction, which has doubtless arisen from unavoidable circumstances, it will be obvious, is exceedingly important to this Department, since it is impossible to depute our well-trained establishments to Native States for a specified period of employment, and to receive them back again at a moment's warning, without deranging both our machinery and financial position.

170. Such forest reserves as, in the opinion of the local Administration, require early survey, will be taken up on the large scale of 4 inches to the mile, and, wherever it is possible, the regular 1-inch survey will also proceed to the extent of the reduced agency employed.

171. Major H. R. Thuillier, R.E., now in sole charge of the combined parties, having previously conducted both Topographical and Revenue, as well as Trigonometrical surveys, I have every reason to believe that the nature of the work required in Mysore will be fully cared for; and when his establishment is completed up to full scale, on the termination of the famine duty, he should be reinforced by an Assistant Superintendent, as provided in the estimates.

172. The Executive Officer reports in the most favorable terms of all the Surveyors and Assistant Surveyors, who have, under exceptionally trying circumstances, performed their duties very satisfactorily, both in the field and recess. Mr. McNair, as before, is highly distinguished by both superior ability and zeal for his profession. It is a matter of the utmost regret to me, that it does not lie in my power to raise this excellent assistant to the position he has so well earned.

No. 9 TOPOGRAPHICAL PARTY.

NAGAR DIVISION, MYSORE SURVEY.

173. This party labored under the same difficulties and obstacles as No. 8, but suffered considerably more from sickness, which, in various forms, raged throughout the Province of Mysore, coupled with the famine and pestilence arising therefrom.

Topography in parts of the Chitaldroog and Mysore districts. Triangulation in portions of the Districts of Nagar, Mysore and Hassan.

174. As in No. 8 Party, no definite programme or systematic and continuous procedure for the season could be adopted, and the Surveyors and Assistants were shifted about to the best advantage. Great efforts were made by the Executive Officer, Captain J. R. McCullagh, R.E., officiating in charge, to start work in the neighbourhood of Mysore, the capital of the Province, pointed out as a likely better or less affected part; and his efforts were so far successful, that he completed the triangulation of a very considerable area, and commenced the detail survey; but the plane-tablers were fairly beaten out of the ground subsequently by cholera and fever, and were moved to a more favorable locality. By dint of hard labor and good management, detail work was commenced, and successfully completed in Standard Sheets 16 and 17, and the better portions of Degree Sheets I, II and XI were triangulated: *vide* Index Map in Appendix.

Strength of Party and Season's out-turn.	Triangulation.	Final topography.
	Square miles.	Square miles.
Major H. R. Thuillier, R.E., Deputy Superintendent, 1st grade, in charge, joined 11th April 1877,	4,311 sq. miles of triangulation. 1,480 sq. miles of reconnaissance.	
Captain J. R. McCullagh, R.E., Assistant Superintendent, 1st grade, officiating in charge, ...		
Mr. H. E. T. Keelan, Surveyor, 3rd grade,... ...		
„ L. J. Pocock, Surveyor, 4th grade, ...		
„ J. W. Macdougall, Assistant Surveyor, 1st grade, on sick leave from 1st August 1877,		
„ H. Todd, Assistant Surveyor, 1st grade, ...	.....	353
„ T. Kinney, Assistant Surveyor, 1st grade, ...	.....	153
„ W. Oldham, Assistant Surveyor, 3rd grade, ...	.....	355
„ E. W. Lasseron, Assistant Surveyor, 3rd grade, resigned from 22nd March 1877,	.....	.....
„ J. M. Kennedy, Assistant Surveyor, 4th grade, ...	.....	.....
Six Sub-Surveyors, ...	.....	.....
TOTAL ...	4,311	861

175. The total area topographically surveyed covers 861 square miles, of which the greater portion is in the Chitaldroog district; the remainder, two small detached areas, in the Mysore district.

Final topography completed.

176. Of triangulation in advance of the detail survey, 4,311 square miles was completed, and 1,480 square miles was reconnoitred, and stations built. Observations were taken at 59 stations, from which 1,371 points were fixed, and 328 elevations determined.

Triangulation completed in advance of topography.

177. The total cost of the season's work amounts to Rs. 59,051-9 under all heads up to the 30th September 1877.

Cost of the season's operations.

178. The whole of the field operations were conducted by Captain J. R. McCullagh, R.E., Assistant Superintendent 1st grade, officiating in charge, to whose zeal and determination much credit is due. The out-turn of final survey is small, but it would have been smaller still, had he not resolutely held his ground against the ever-increasing difficulties caused by famine and disease; and I much regret the loss temporarily of his services with the party, by his departure on furlough* on the 1st of November last, as his knowledge of the country and its people was of great value.

Opinion of the season's work.

* *Vide* G. G. O. No. 912, dated 9th October 1877.

179. Captain McCullagh was relieved of the charge of No. 9 Party on its return from the field by Major H. R. Thuillier, R.E., Deputy Superintendent, 1st grade (who had previously been officiating as Superintendent of the Great Trigonometrical Survey during Colonel Walker's absence in England), on the 11th April 1877, and he then received charge of No. 8 Party from Captain George Strahan, R. E., proceeded on furlough, as has been noted in the report of that party. Nos. 8 and 9 parties have now been combined and formed into one, with the object of reducing the estimates consequent on the famine.

180. Both Captain McCullagh and Major Thuillier report favorably on the good services rendered by the Surveyors and Assistants who still remain with this party. Mr. T. Kinney, Assistant Surveyor, 1st grade, was transferred to the Great Trigonometrical Survey from 12th May 1877, and Messrs. W. Oldham and J. M. Kennedy were transferred temporarily to do duty with the Public Works Department. Mr. E. W. Lasseron, Assistant Surveyor, 3rd grade, resigned his appointment on the 22nd March 1877 for superior employment in the Mysore Revenue Survey. Mr. J. W. McDougall, Assistant Surveyor, 1st grade, obtained medical leave for one year, from the 1st August 1877, as his health completely failed, and he was unable to take any share in the season's work.

181. The whole establishment suffered considerably in health, and for a time nearly three-fourths of it was on the sick list. One man died from the effects of malarious fever and six from cholera.

182. The entire area triangulated in advance in Mysore by the two parties, now amounts to 19,403 square miles, of which only 2,326 square miles have come under topographical delineation as yet. The reduction of the strength of the establishments to about one-half will, of course, more than double the probable time for completing such an undertaking. The desire of the local Administration was, that the whole survey of 24,881 square miles, the area of the Province, should be completed in 5 years; but with the present allowed agency it is doubtful if such an undertaking will be accomplished in 12 years from the time of commencement. So much depending on local causes and climatic influences extending over such an area, I was unable to fix any specified period within which so extensive a survey could be brought to a close, and the effects of the famine and pestilence, which have devastated the Province, form a sufficient commentary on the uselessness of making any positive forecast of this nature. The ordinary progress may be put down at 2,000 square miles per season, under favorable circumstances, by such a party.

183. It is most desirable that due and proper progress should be made in carrying out this extensive survey. It is to be hoped, therefore, that the reduction now recommended on financial grounds, may prove only temporary, and that in another year or two the second party may again be put on to the work, with the view of getting it out of hand within a reasonable time. The single establishment now authorised should be kept in as full and efficient a state as possible, in order to secure a fair return of progress, and to keep the mean average mileage rate as low as it ought to, and may be, under proper management. A survey establishment is always the more effective, the stronger it is, and the proportion of subordinates, both European and Native, should be carefully regulated by the cost of superintendence. Unless this is observed, the mileage rate must be injuriously affected; and this is the great test of the real cost of a survey.

184. The prospects of the present season in Mysore are declared to be much better than could have been expected; the appearance of the famine and pestilence has disappeared, pasturage and cultivation is universal everywhere, and, except as to the partially-deserted nature of the villages, the recent suffering is nowhere visible. Major Thuillier states that his work is consequently now progressing as favorably as could be desired, and it is to be hoped that no more sickness will appear.

H. L. THUILLIER, *Major-General,*

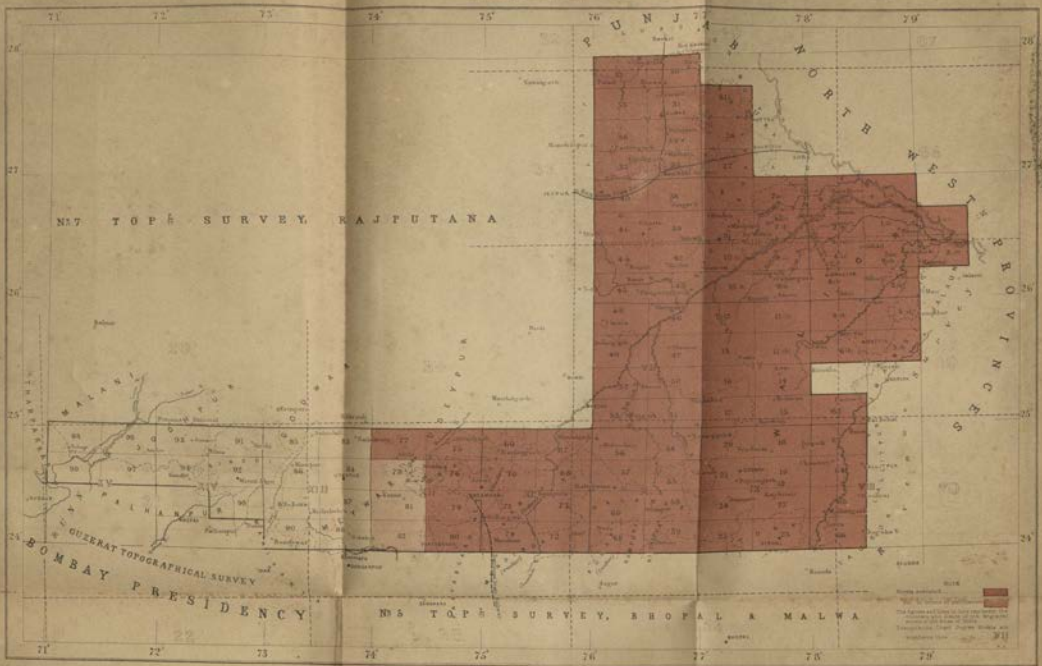
Surveyor General of India.

SURVEYOR GENERAL'S OFFICE,
CALCUTTA,
The 28th December 1877.

No. 1 PARTY.

INDEX TO THE SHEETS OF THE GWALIOR & CENTRAL INDIA TOPOGRAPHICAL SURVEY.

On the Scale of 1 Inch to 1 Mile.

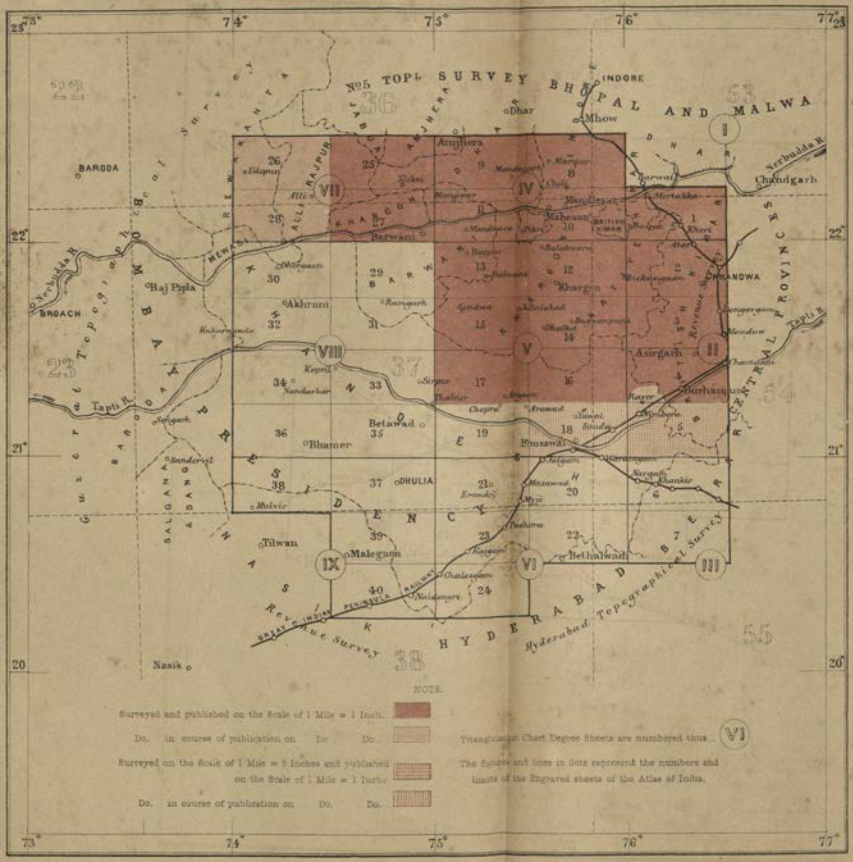


Published under the direction of Major General H. L. Thuillier, C.B., R.E. Surveyor General of India.
Surveyor General's Office, Calcutta, January 1865.

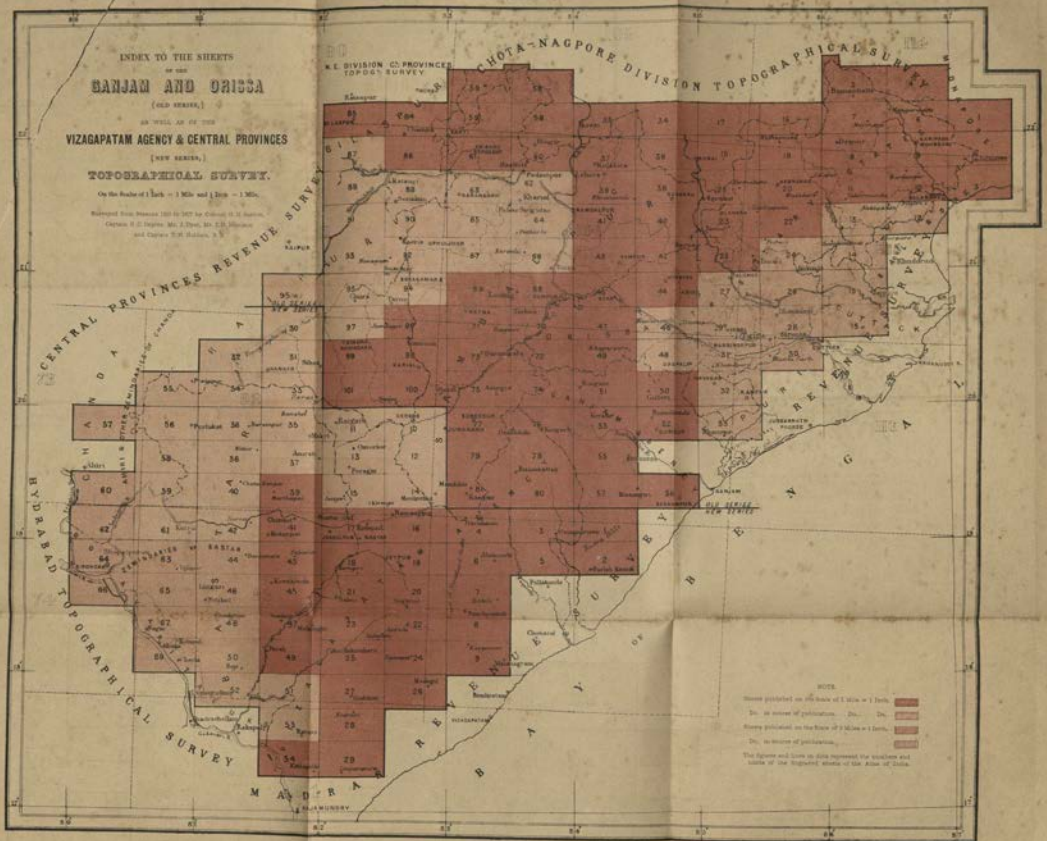
No. 2 PARTY

INDEX TO THE SHEETS OF THE KHANDESH & BOMBAY NATIVE STATES SURVEY.

On the Scales of 1 Inch = 1 Mile and 2 Inches = 1 Mile.



Published under the direction of Major General H. L. Thuillier, C.B. - F.R.S. Surveyor General of India,
Surveyor General's Office, Calcutta, December 1877.

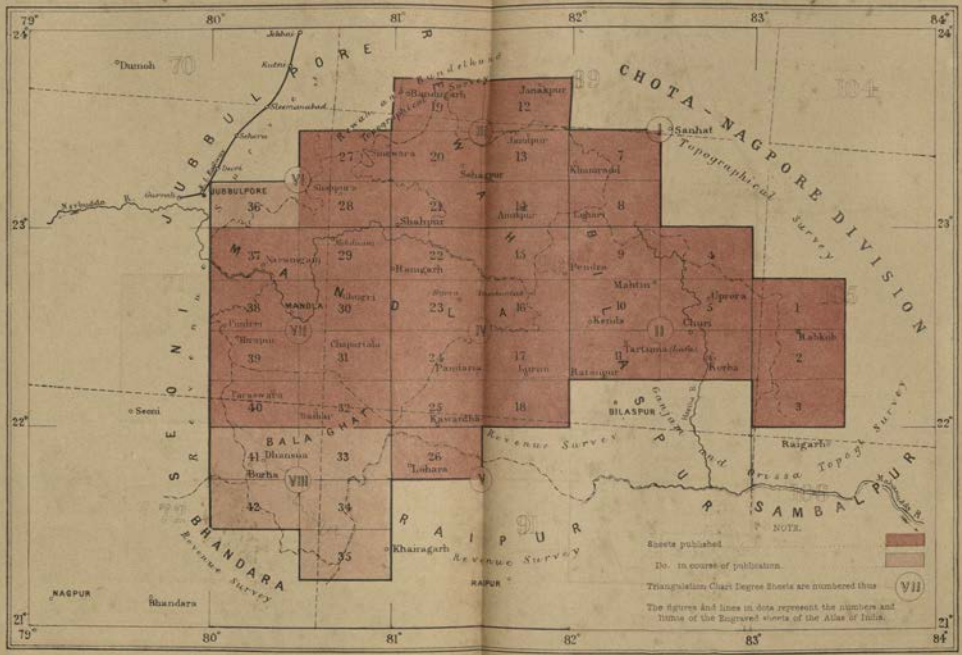

INDEX TO THE SHEETS
OF THE
GANJAM AND ORISSA
(OLD SERIES.)
AS WELL AS OF THE
VIZAGAPATAM AGENCY & CENTRAL PROVINCES
(NEW SERIES.)
TOPOGRAPHICAL SURVEY.
On the Scales of 1 Inch = 1 Mile and 2 Inch = 1 Mile.
Surveyed from Seasons 1855-56-1857 by Colonel G. C. Morton,
Captain H. C. Depree, Mr. J. Dyer, Mr. C. D. Morrison
and Captain T. H. Hudson, R. E.
N.E. DIVISION CP. PROVINCES
TOPOGR. SURVEY
CHOTA-NAGPORE DIVISION TOPOGRAPHICAL SURVEY
CENTRAL PROVINCES REVENUE SURVEY
HYDRABAD TOPOGRAPHICAL SURVEY
MADRAS REVENUE SURVEY
BAY OF BENGAL
NOTE.
Sheets published on the Scale of 1 Mile = 1 Inch.
Do. in course of publication. Do. Do.
Sheets published on the Scale of 2 Miles = 1 Inch.
Do. in course of publication.
The figures and lines in dots represent the numbers and
limits of the Highland sheets of the Atlas of India.

Published under the Direction of Major General H. L. Thuillier, C.B., F.R.S. Surveyor General of India.
Surveyor General's Office, Calcutta, December 1871.

No. 4 PARTY

INDEX TO THE SHEETS OF THE NORTH EAST DIVISION CENTRAL PROVINCES TOPOGRAPHICAL SURVEY.

On the Scale of 1 Inch = 1 Mile.

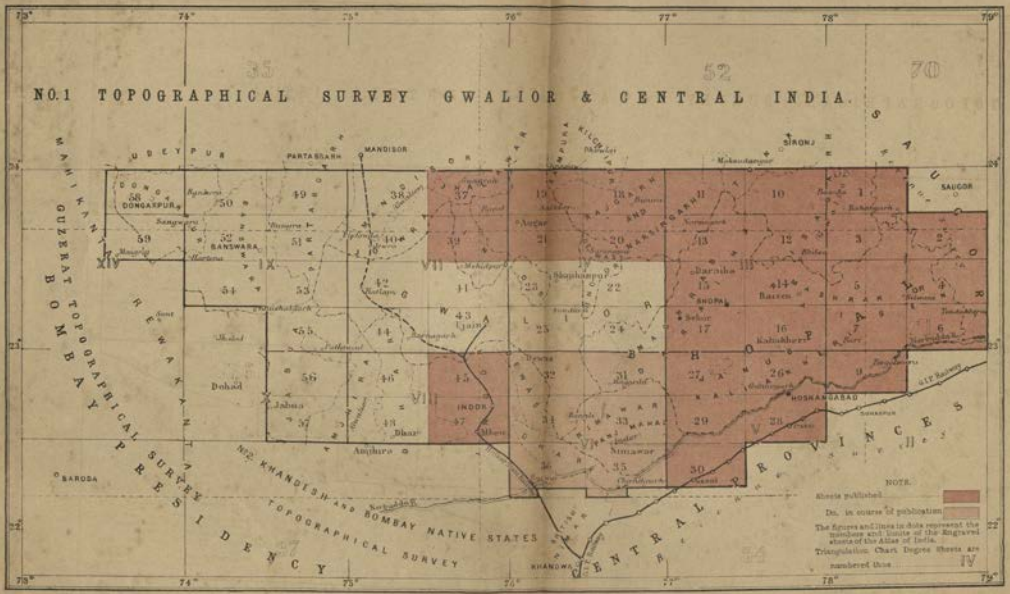


Published under the direction of Major General H. L. Thuillier, C.B.I. – F.R.S. Surveyor General of India.
Surveyor General's Office, Calcutta, December 1877.

No. 5 PARTY

INDEX TO THE SHEETS OF THE BHOPAL & MALWA TOPOGRAPHICAL SURVEY.

On the Scale of 1 Inch = 1 Mile.

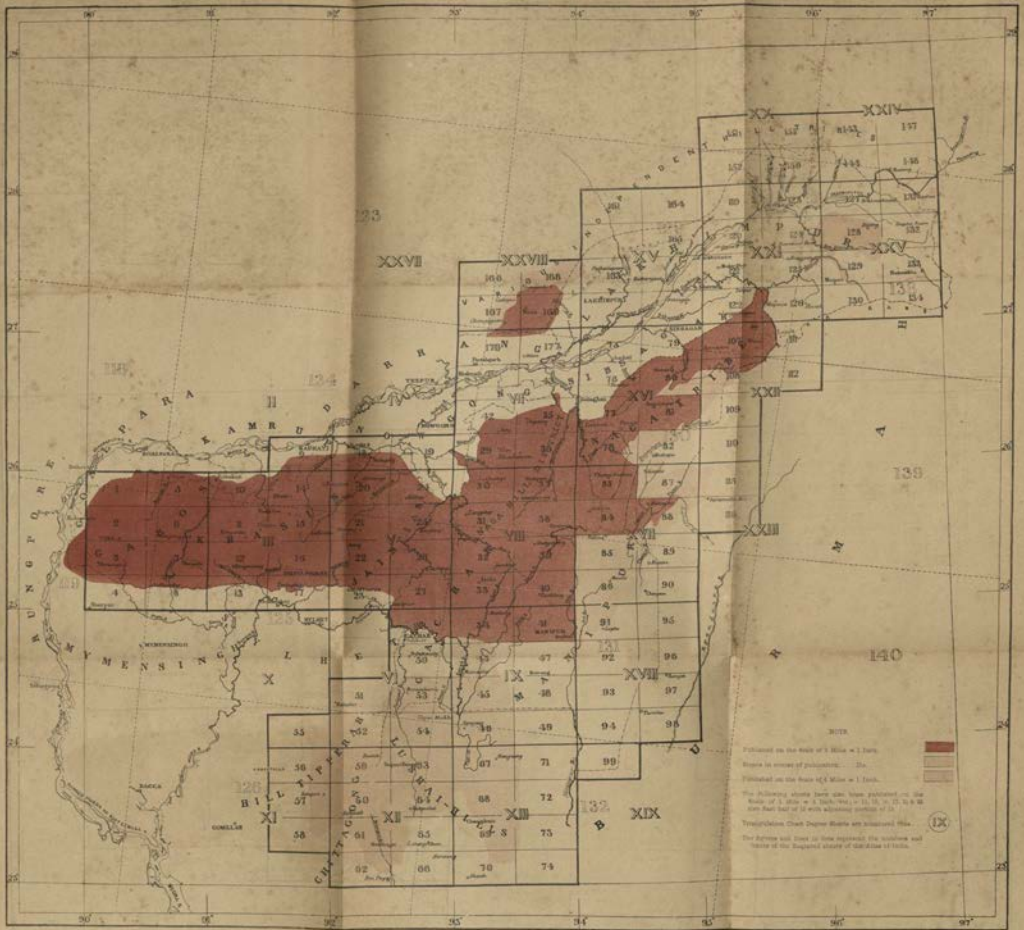


Published under the direction of Major General H. L. Thuillier, C.B.I.—F.R.S. Surveyor General of India.
Surveyor General's Office, Calcutta, December 1877.

No. 6 PARTY

INDEX TO THE SHEETS OF THE GARO, KHASI AND NAGA HILLS TOPOGRAPHICAL SURVEY

On the Scales of 1 Inch = 1 Mile, ½ Inch = 1 Mile and ¼ Inch = 1 Mile.

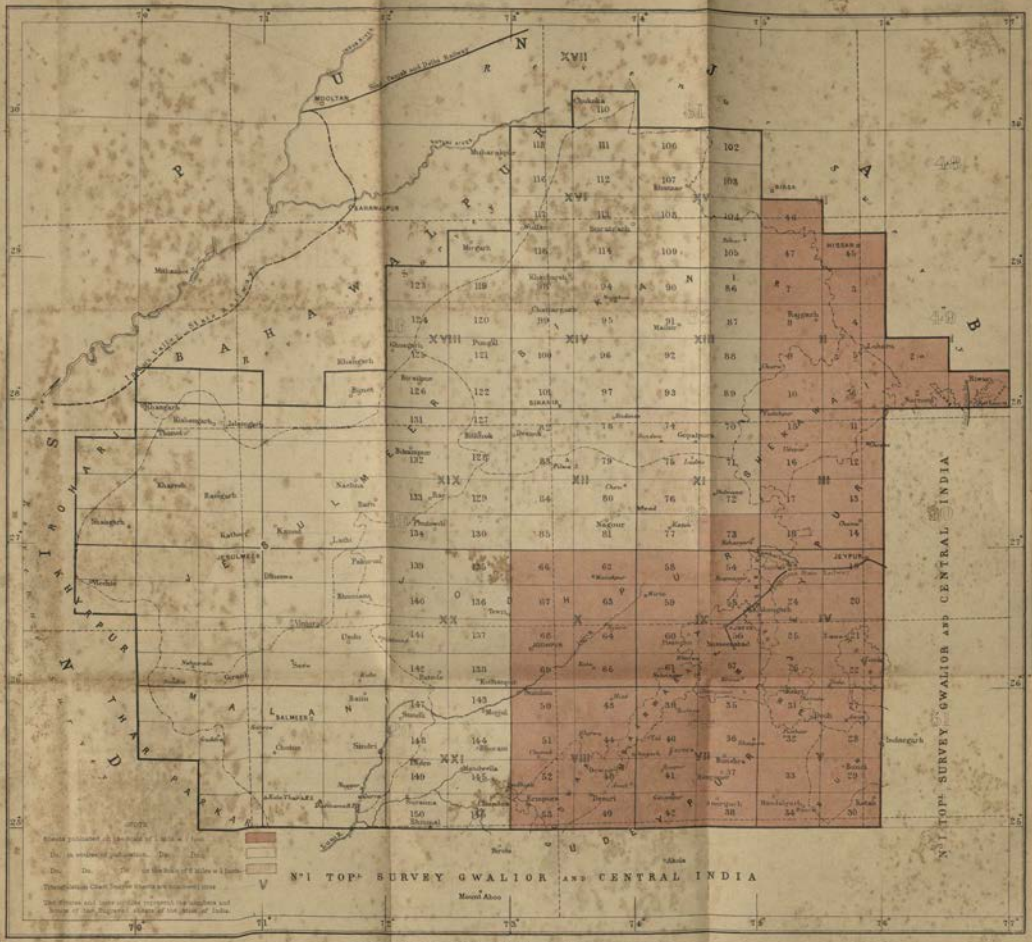


Published under the direction of Major General H.L. Thuillier, C.B.I.—F.R.S. Surveyor General of India.
Surveyor General's Office, Calcutta, December 1877.

No. 7 PARTY

INDEX TO THE SHEETS OF THE RAJPUTANA TOPOGRAPHICAL SURVEY.

On the Scales of 1 Inch = 1 Mile and ½ Inch = 1 Mile.

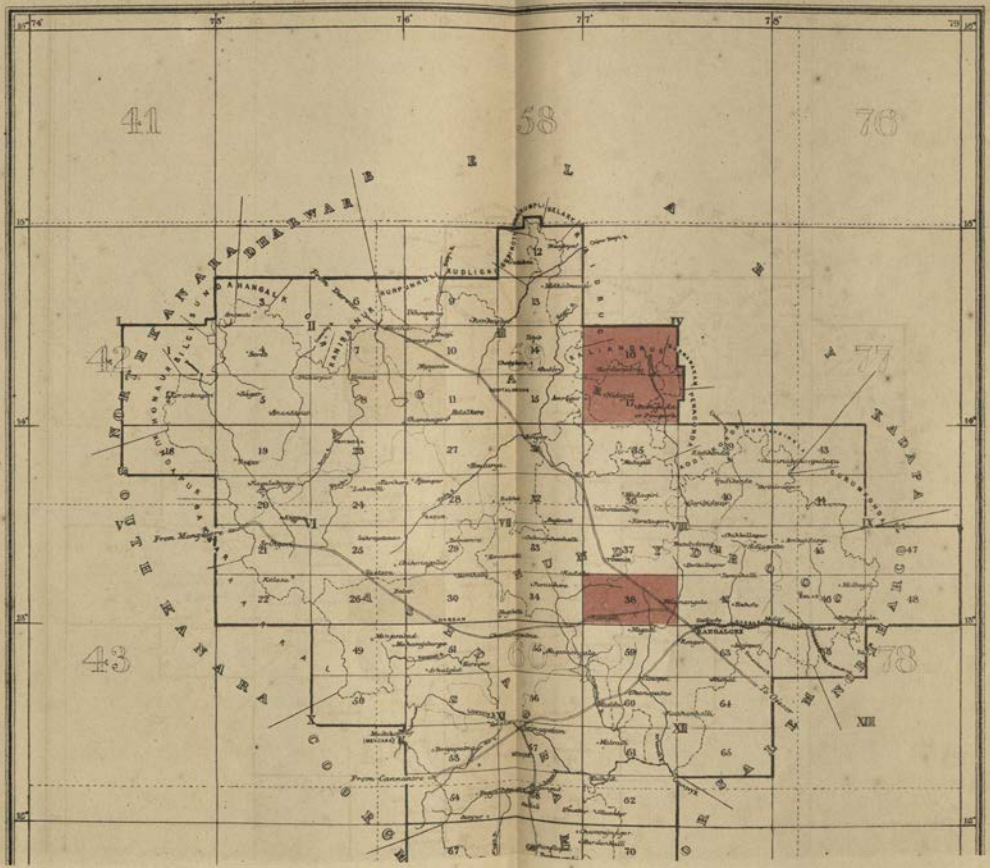


Published under the direction of Major General H. L. Thuillier, C.B., F.R.S. Surveyor General of India.
Surveyor General's Office, Calcutta, December 1877.

Nos. 8 & 9 PARTIES.

INDEX TO THE SHEETS OF THE MYSORE TOPOGRAPHICAL SURVEY

On the Scale of 1 Inch = 1 Mile.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BELLARY
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HANNARA

APPENDIX.

STATEMENT A.

Showing progress and present cost of each Survey during 1876-77.

Surveys.	Final topography completed, square miles.	Triangulation completed, square miles.	Stations observed at.	Number of points fixed.	Square miles to each point.	Heights trigonometrically determined.	Square miles to each height.	Amount of fair mapping rendered on the 4", 2", 1" and ½" scales.	Total cost of survey.	Remarks.
No. 1.—Gwalior and Central India	1,568·1	...	8(a) 7(b)	171(a)	... ...	61(a)	... ...	1,661 ...	58,632 ...	(a)—Gwalior, Morar, and environs on 24", 12" and 6". (b)—Chittore.
„ 2.—Khandesh and Bombay Native States ..	1,840·7(c)	638	15 59	187	3	212	3	1,706	51,242	(c)—Includes 819·8 square miles on the 2" scale.
„ 3.—Central Provinces and Vizagapatam Agency ...	3,225(d)	...	...	...	...	...	...	3,220	47,119	(d)—On ½" scale.
„ 4.—North-East Division, Central Provinces	1,227·5(e)	...	39	44	...	13	...	1,265	44,925	(e)—Includes 7·5 square miles on scale 1"=1 mile.
„ 5.—Bhopal and Malwa ...	2,968·28(f)	2,867	59	357	8·0	277	10·4	2,968	61,067	(f)—Includes 83·44 square miles overlap.
„ 6.—Khási, Gáro, and Nágá Hills ...	2" = 1 M. = 160 1" = „ = 369 ½" = „ = 717 1,246	2,046	53	228	8·9	27	77	4,040	62,859	
„ 7.—Rajputana ...	4,507·6(g)	6,977	59	515	13·6	407	17	4,228	34,953	Square Miles. (g)—1"=1 mile ... 4495·6 Simla, 74 acres on scale of 200 ft.=1 inch ... 0·1 6"=1 mile, Jodhpore ... 12·3
„ 8.—Mysore ...	1" = 1 M. = 1,417 4" = „ = 47·6 1,464·6	5,280	95	770	6·8	555	9·5	579	62,109	
„ 9.—Mysore ...	861	4,311	59	1,371	3·1	328	13·5	570	59,052	
Total ...	18,908·8	22,119	438	3,643	mean 7·2	1,880	mean 21·7	20,237	4,81,958	Including cost of Mysore survey, Rs. 1,31,161.

STATEMENT B.

Professional results and value of the Season's triangulation and average number of plane-table station fixings of detail survey, Season 1876-77.

Surveys.	Number of Triangles. 1st class.	2nd class.	Tertiary or intersected points.	Triangular error in seconds. 1st class.	2nd class.	Mean difference of common sides in inches per mile. 1st class.	2nd class.	Tertiary.	Average plane-table fixings in each square mile of detail survey.	Number of linear miles of check lines run.	Remarks.
No. 1—Gwalior and Central India, ...	...	18(a) 11(b)	309(a) ...	...	·4(a) 2·6(b	...	1·4(a) 0·7(b)	6·4(a)	13·1 on 1"	32·5	(a)—Gwalior. (b)—Chittore.
No. 2—Khandesh and Bombay Native States	...	83	341	...	13·9	...	4·0	5·7	7·4 on 1" 15·5 on 2"	111·1 on 1" 953 on 2"	
No. 3—Central Provinces and Vizagapatam Agency, ...	...	...	...	...	...	.....	...	...	2·1 on ½"	84 on ½"	
No. 4—North East Division, Central Provinces	...	2	86	...	...	...	18	48	9·8 on 1" 48·2 on 4"	69·9 on 1" 2·1 on 4"	16·1 linear miles of Forest boundary.
No. 5—Bhopal and Malwa	1	95	826	2·2	3·5	...	2·5	4·3	8·1 on 1"	344·0	
No. 6—Khási, Gáro, and Nágá Hills ...	...	57	277	...	13·3 (1") 14·8 (2")	...	9·6(2")	54 (½") 16 (½")	2·0 on 1" 9·4 on 2"		250 miles of route Survey on 1" scale.
No. 7—Rajputana ...	13	127	758	3·3	2·9	...	1·7	5·2	2·1 on 1"	Examined in situ.	
No. 8—Mysore ...	...	161	1,350	...	4·4	...	2·6	7·8	7·0 on 1" 59·2 on 4"		
No. 9—Mysore ...	...	79	1,292	...	4·9	...	2·8	12	3·2 on 1"		
Totals and Means	14	633	5,239	Mean 2"·8	7"·4	...	Mean in. 4·8	Mean in. 17·7	Mean 6·59 on 1" 12·45 on 2" 53·7 on 4" 21·7 on ½"	Linear Ms. 557·5 on 1" 953·0 „ 2" 18·2 „ 4" 334·0 „ ½"	

STATEMENT C.

Comparative results of seasons 1875-76 and 1876-77, with general average mileage rates.

	Final topography, square miles.	Triangulation, square miles.	Number of stations observed at.	Number of points fixed trigonometrically.	Heights determined trigonometrically.	Cost.	Rate per square mile.	Remarks.
						Rs.	Rs. A. P.	
Season 1875-76	19,188	19,430	336	1,838	1,475	3,86,332	20 2 2	
„ 1876-77	18,909	22,119	438	3,643	1,880	4,81,958	25 7 9	
	−279	+2,689	+102	+1,805	+405	+95,626	+5 5 7	

STATEMENT D.

Abstract Cash Account of Moneys received from 1st January to 31st December 1877.

Dr. *Cr.*

Items.	Amount.	Total amount.	Items.	Amount.	Total amount.
To Map-sale Account.	Rs. A. P.	Rs. A. P.	*By Transfer Account.*	Rs. A. P.	Rs. A. P.
Balance in hand on the 1st January 1877 ...	309 7 9		Amount paid to General Treasury, *vide* No. 85, dated 11th January 1877, ...	309 7 9	
Amount received from sundries	2,536 3 0½		Amount paid to General Treasury, *vide* No. 298, dated 8th February 1877, ...	634 12 10½	
Sales by Messrs. Thacker, Vining and Co., Bombay, up to 30th November 1876	171 3 0		Amount paid to General Treasury, *vide* No. 513, dated 5th March 1877, ...	98 14 8	
Sales by Curator of Government Books, Nagpur ...	48 14 8		Amount paid to General Treasury, *vide* No. 749, dated 2nd April 1877, ...	80 8 0	
Sales by Messrs. Thacker Spink and Co., up to 30th November 1876 ...	2,251 11 0		Amount paid to General Treasury, *vide* No. 465, dated 28th February 1877, ...	2,251 11 0	
Sales by Messrs. Higginbotham and Co., Madras, up to 30th November 1877	110 14 0		Amount paid to General Treasury, *vide* No. 932, dated 2nd May 1877, ...	222 9 0	
Sales by Mr. W. Ball, successor to the Punjab Printing Co., Lahore, up to 30th November 1877, ...	147 8 0		Amount paid to General Treasury, *vide* No. 1142, dated 15th June 1877, ...	156 10 6	
Sales by Curator of Government Books, North-Western Provinces, Allahabad ...	91 13 0		Amount paid to General Treasury, *vide* No. 1279, dated 12th July 1877, ...	74 6 9	
		5,670 10 5½	Amount paid to General Treasury, *vide* No. 1179, dated 21st June 1877, ...	649 12 8	
			Amount paid to General Treasury, *vide* No. 1433, dated 14th August 1877, ...	240 12 0	
			Amount paid to General Treasury, *vide* No. 1519, dated 7th September 1877, ...	210 2 9	
			Amount paid to General Treasury, *vide* No. 1637, dated 5th October 1877, ...	192 5 6	
			Amount paid to General Treasury, *vide* No. 1809, dated 13th November 1877, ...	129 2 0	
			Amount paid to General Treasury, *vide* No. 1995, dated 11th December 1877, ...	28 8 0	
			Amount paid to General Treasury, *vide* No. 2116, dated 27th December 1877, ...	390 15 0	
					5,670 10 5½
Total ...	.....	5,670 10 5½	Total ..	.....	5,670 10 5½

H. L. THUILLIER, *Major-General,*
Surveyor-General of India.

Memorandum showing the total amount recoverable from the Map-sale Agents for sales up to 30th November 1877.

	Rs. A. P.
Messrs. Thacker, Spink and Co., Calcutta	3,595 2 0
Curator of Government Books, Central Provinces, Nagpur	83 4 0
Total ...	3,678 6 0

APPENDIX.

Extract from the Narrative Report of CAPTAIN CHARLES STRAHAN, R.E., *Deputy Superintendent in charge No. 1, Gwalior and Central India Topographical Survey Party.*

Remarks on country plane-tabled. Gwalior Territory.

The country under survey this season was divided into two by the water-shed of India, which here runs north-west and south-east. The difference between the two tracts thus divided is most remarkable; the north-east portion being very flat and quite open, with several large towns and villages, and fairly well cultivated; it forms part of the plateau of Rajputána, and is on an average about 1,600 feet above the sea. Villages are tolerably numerous, and several are of large size, but still I should by no means call it a thickly-populated country; in consequence of this, I believe, and not so much for want of water as I have heard stated, a considerable portion of the land is not under cultivation; the surface is more or less undulating, and it is true on the higher portions of the undulations the soil is generally rocky and poor, but still in the lower parts large wastes may be found, which to all appearance would repay cultivation. Almost every village has a tank, some of them of very large size; the water is used pretty considerably for irrigating the fields below the dam; but the water being conveyed only in channels dug in the soil, the waste of water must be very great. Being so near the water-shed, there are necessarily no large rivers. The Berach, a branch of the Banás, and its two tributaries, the Bágan and the Wankli, are the only streams of any note. The change after crossing the water-shed is very abrupt; instead of a fine, open, undulating, and almost level country, the whole surface is intersected by water-courses, which gradually become deeper and deeper, at last forming narrow valleys enclosed by hills varying from 100 feet up to about 500 feet above them. The fall of the country is very considerable; for the height of the Som river, the lowest point obtained, is 650 feet above the sea, shewing a drop of 950 feet from the plateau above, in a distance of 25 miles, or nearly 40 feet per mile; and again from Bánsi to Dariawad 17 miles, a fall of 850 feet, or 50 feet per mile. This rapid fall is, no doubt, the cause of this intricate hilly bit of country; for the large amount of drainage rushing for centuries down this slope of upwards of 40 feet a mile is, I should think, quite sufficient to account for it all. The first 10 or 12 miles of this ground is more or less covered with jungle, and the hills being of an almost uniform height, the difficulties encountered in surveying it were very great.

As you continue southwards the ranges become higher and higher, or, more strictly speaking, the valleys become deeper and deeper, and plane-tabling could be carried on more or less; but the jungle on them is, if anything, even heavier than in the upper portions, and the labor of getting about was very great, consequently, although traversing could be dispensed with, progress was still very slow. The drainage of the eastern part of this country is into the Jákhum river, a branch of the Som river, the course of which is from north-east to south-west; to the west it all flows into the Som, which here flows from west to east. These two rivers, of which the Som is by far the larger, after their junction flow into the Mahi. A very large portion of this western drainage is stopped by the Debar lake, described last year by Lieutenant Hobday. During the early part of the cold weather the overflow from the lake forms no inconsiderable stream in itself, but what with evaporation and irrigation, little or no water reaches the Som from this source after December. Having fairly passed through this rugged belt and reached the low country about the Som river, the country becomes far more open, with numerous villages and a fair amount of cultivation. Hills are still numerous, but they do not form large unbroken masses; and Dúngarpur, the State to the south of the Som, did not, as far as I could see, present any very great difficulties to a surveyor. Nearly the whole of the season's work belonged to Meywar; only on the plateau above are found a few detached portions of Tonk and Gwalior, below the water-shed, but very little revenue goes direct to the Durbar of Oodeypore, as it almost all belongs to the Thakurs (or Raos) of Salúmbar, Bhíndar, Bánsi, Kanur, Dariawad, Korábar and Bamora, and others of less note; and again between the Debar lake and the Som are a great many villages belonging to Brahmins, who pay no revenue at all.

Forts, towns and cities.

Of first class forts we found none, nor any second-rate ones worthy of mention. The principal towns in order, according to their size, are as follow: Salúmbar, Bhíndar, Kánur, Korábar, Dariawad, Bamora, Bátáru, Bansi, all residencies of Thakurs, of which the first three and Bánsi belong to four of the upper sixteen nobles of Meywar. The four first on the list are surrounded by a wall, but are not of any importance as fortified places. Besides these may be mentioned the tehsils of Kheroda, Untala, Boara and Lunda.

Passes.

We found only two passes from the plateau down to the low country which call for notice: one from Bánsi running almost due south to Dariawad and thence to Bánswára in the Bhopal survey, as it may be considered part of a good line of communication between Oodeypore and Bánswára. I shall report in detail on it amongst the routes. The other pass from Salúmbar to Oodeypore, I shall also make a special report on. Neither of these passes can be traversed by carts, but all sorts of baggage animals can easily pass through, laden. A few

other roads through the hills are shewn on our maps, but they are as a rule principally wood-cutters' paths, or only connect unimportant places, and are not well known at all; one is perhaps worth noting, from Dariawad up the Ratia-Kankar valley to Anjeni, and thence through the villages of Kharka, Gurel and Gharla, to Korábar up to Ratia-Kankar; it is a rough jungly road, but fairly level and easy for baggage animals between Ratia-Kankar and Anjeni; it is a mere footpath over the hills, but still accessible for laden camels with a little difficulty: from Anjeni to Korábar it is a good road, but not fit for wheeled vehicles of any sort. Dariawad and Salúmbar are connected by a road quite easy for baggage animals; it leaves Dariawad in a west-south-west direction, past the villages of Hawala, Arbara, and the small hamlet of Daran-ka-Khera, on the Jákhum river, through open country; it then passes through high jungly hills, but without any very formidable ascent or descent. Beyond the high hills the country is undulating, but still covered with jungle up to the village of Mánpur, where there is some cultivation and a little open space. Beyond Mánpur, again, is nothing but jungle up to Mátásola, but thence to Salúmbar there are no more hills and but comparatively small tracts of bush jungle. On the plateau above you can go almost where you like, either with or without a road, and there is no necessity for pointing out any particular routes in this report. The regular lines of communication will all be noticed amongst the routes.

Rivers.

The Jákhum and the Som, already spoken of, were the only rivers met with; the Berach, which afterwards becomes a good-sized stream, is here of quite secondary importance; when crossing it marching up, it was no longer even a flowing stream, the water lying in large pools. Neither the Jákhum nor the Som are navigable, nor could they ever be made so.

Inhabitants and crops.

In classifying the inhabitants, it is again necessary to divide the country into two by the water-shed. To the north, in the cultivated parts, the upper classes are all Rajputs, but the ryots or working classes are of the Dhákar, Dángis and Kalmi caste. In the rainy season, Indian corn and jowar form the principal crops; in the cold weather, wheat, barley and opium, of which opium is the crop from which the greatest revenue is obtained: from jowar about Rs. 2 per beegah is levied, from wheat and barley from Rs. 3 to Rs. 4 per beegah, and from opium from Rs. 8 to Rs. 12. In the hilly country below the water-shed are only to be found Bheels and Minas, these latter being almost identical with the Bheels; the Minas consider themselves slightly superior, but the only difference any of us could ever discover between them was, that a Bheel will eat camel and alligator and even tiger, whereas Minas will not. They both eat cattle and all sorts of deer.

These Minas must not be confounded with the Minas and Gujars of the northern parts, so well known, as a rule, as cattle-lifters. These are allied to the Rajput tribes, and are called Ujla (Anglice, clean) Minas, and have no connection at all with the others I am speaking of, who are aborigines and are distinguished as the Maila (Anglice, dirty) Minas. Nearly all the inhabitants of the "Páls," as they call their villages, met with this year were Minas; only a few Bheels proper were found near the Debar lake. Very little opportunity was thus afforded of finding out the different clans or sub-divisions of this tribe of the Minas. Lieutenant Hobday obtained the names of several, *viz.*, the Buj, Báror, Katara, Damar, Mal, Bargate and Kandar. Sub-Surveyor Abdul Sobhan gives another, *viz.*, the Armor, which he says is the highest in rank of all and are distinguished in dress by wearing short drawers, whereas all the others wear the ordinary "*dhoti*"; and again a Mina, not of the Armor class, greets one of this caste by unstringing his bow, and not with the ordinary salam and greeting of "Ram Ram." A man may not marry into his own clan, but must select a wife from some other one; but the Armor will only allow their daughters to marry into the Bargate. An Armor may, however, take for his wife a member of any other clan. These aboriginal tribes all live in the most inaccessible country amongst the hills; they never build regular fixed villages, but inhabit a valley, each man building his hut where he likes; this collection of huts, sometimes extending over some miles, is called a "Pál," and as a rule the inhabitants of one "Pál" are all of the same clan, but not necessarily so, for sometimes they are curiously mixed; they are all considerably addicted to drink and are very independent. During any of their great festivals they are sure to be more or less intoxicated, and it is advisable to keep clear of them at such times, as they are apt to get quite beyond control, and very little is sufficient to bring them out under arms against any intruder. At any time any act of oppression towards a Bheel or Mina within a "Pál" is sure to call forth the war cry, which echoing up and down the valley is answered all round and speedily collects the others to the spot; it then requires some little tact to smooth matters and prevent recourse to arms. This happened more than once, but never through any fault of the members of the party, but in consequence of some camp-followers trying to bully a Mina, in virtue of his being attached to an Englishman's camp. These wild men, however, appeared to be open to reason, for they always quieted down when they saw that there was no intentional injustice on our parts and that oppression would not be allowed. On the whole they are not very difficult to deal with if you start fair with them, and if they clearly understand that you do not wish to do them any harm. Although they are much addicted to robbery, sending out regular gangs to waylay merchants and rich travellers, no case of robbery occurred in any of our camps. They are essentially idle, and it was very difficult at times to procure coolies; and whilst out at work, a Mina, when acting as flagman, would often run away, having previously tied his flag to a bush to prevent suspicion; setting this aside, they did not impede our survey operations in any way. They cultivate the ground close to the streams in their "Páls," irrigating them from the streams by means of Persian wheels, and they also grow "jowar" on the hill sides

by the process of "Bhalra" or "Sur;" they cut down the jungle and burn it when dry; a man then drills holes with a stick, in which he puts the seed without any further preparation of the ground. As a rule, they select different places each year for such cultivation. On these crops no tribute is levied. They prize the Mowah trees greatly, from the flowers of which they distil their liquor. In every "Pál" may be found a distillery, and when the flowers are in full bloom, you see men, women and children collecting the fallen flowers. They almost invariably go about armed with bows and arrows, but seldom have other arms. Their bows are of bamboo, well hardened in the fire, and although short, are of considerable strength. The curious part of them is, that the string is also a strip of bamboo; neatly and carefully bound at either end are loops of sinew, which catch in the notches at the extremities of the bow; the arrows are also of small bamboo, with four feathers, strongly, but rather coarsely bound on, and pointed with flat iron in the shape of a spear-head also bound on; they are rather too heavy at the point, but fly fairly truly. From what I saw they did not appear to be very skilful shots, even at a range of about 30 yards.

Wild animals.

Notwithstanding the amount of jungle and the wild character of the country, there are wonderfully few animals to be found. In places a few "Sambhar" may be seen, and bears are met with now and then, but they are by no means plentiful. "Chital" were not even heard of. The small jungle four-horned antelope was seen in several places. Tigers and leopards are scarce; but pigs were met with in the "Dhankeri" jungle pretty frequently. There is very fair fishing to be had in the rapids of the Som and Berach rivers, but not much in the Jákhum river. With regard to the fish, there is one fact well worth noting and of which there is apparently no doubt—in all the streams which belong to the Bay of Bengal drainage, even in very small ones, the Indian trout is very plentiful, and during March and April can be caught by dozens with fly; whereas they are absolutely unknown in the rivers and streams flowing to the Gulf of Cambay. The "Mahseer" is to be caught in most of the large streams on both sides of the water-shed.

Minerals.

Lieutenant Hobday reports that in the hills between Bedawal-ki-Pál and Anjeni he found on certain ranges large quantities of iron ore, and a little to the west again, copper ore. In the days of the Rahtors these ores appear to have been worked, but no exact information about the time of working them could be ascertained; they are not made use of at all now-a-days.

Trees, &c.

Large quantities of teak were found in the forests, but as they are in no way preserved, the Minas and Bheels cut them all down when young, and few large trees are to be found. Now and then a fine specimen may be found growing over some sacred spot. The "Mowah" trees are very plentiful and are much valued on account of its flowers, from which liquor in large quantities is distilled; they also dry the flower and mix it with their bread. From the fruit they extract oil. The male bamboo grows in quantities about the hills, more particularly about Bidawal-ki-Pal. The "Tendu," or ebony tree, was found in considerable quantities. In many places the "Kiwanch" (Anglice, cowhage) caused great annoyance from the irritation caused by the hairy pods, the natives more particularly suffering from it on their bare arms and legs. "Jamalgota" (*Croton tiglium*) is also to be seen more or less everywhere, but Abdul Sobhan states that, between the villages of Nar, Kontha, Mánpur and Palsora, it was in such quantities that the water in the streams was quite impregnated with it, and that he and all his men were completely laid up when working there. The inhabitants also suffer greatly in that neighbourhood.

Notes by Sub-Surveyor ABDUL SOBHAN *on the Bheel clans of Meywar.*

The territory of Meywar is divided into five portions, known under the following names: Meywar, Sappan, Meval, Katara or Kantar and Magra (Anglice, hilly country). To the south of Gamra, near the Debar lake, lies the Sappan division, the capital of which is Salúmbar; to the north of this is the Meval district, capital Kanor. The whole of Katara now no longer belongs entirely to Meywar, the present state of Pertabgarh having formed a large portion of it; its ancient capital was Pertabgarh, but the principal town in that part of it, now belonging to Meywar, is Dariawad. Meywar proper occupies the centre, and its capital is Oodeypore. The country known as the Magra includes all the Aravalli range both north and south of Oodeypore. The Sappan, Meval, Katara and Magra divisions are occupied principally by the Bheel tribes, of whom the Minas form one; they assert their origin from the Rajputs, but these latter do not admit it. Their clans (Got, is their term for a clan) are known as the Armor, Buj, Báror, Kattara, Damar, Mál, Bargot and Kandar; the first is acknowledged to be the chief, the others all pay homage to them. Their villages are called "Pals" (the literal meaning of which is an embankment of a tank). To cultivation, these Bheels, like all other aboriginal hill tribes, pay little or no attention, but make their living principally by plundering and cattle-lifting. They are acknowledged to be brave men; the following triplet being in praise of them: "*Rani jáio, Mini jáio, Marta áio*, which freely translated means that the offspring of a queen or of a Mina scorns death. Especially it is a matter of note that no exhibition of feeling should be shewn for those who have been killed in a raid, but at the same time the spot where any man has fallen is

marked by a pile of stones, each man adding to the pile as he passes it. These piles of stones are very constantly met with, showing how very frequently such casualties occur. Their chief wealth consists in the number of cattle they possess, and these are almost invariably obtained by force from their neighbour. Every "Pál" is governed by a "Gammeti," whose power in that "Pál," is paramount, and who is assisted by one or more "Gaddas." They only appreciate the coarser kinds of grain for food, and altogether reject wheat. They eat not only all wild animals of the deer tribe, but also dead cattle, although they will not, like all Hindoos, kill them. They do not touch opium which is remarkable, living, as they do in a country where this drug is so universally used; but they are very much addicted to liquor; the women however, religiously abstain from it. They do not court marriage for their daughters, and only give them away when men of their own accord come forward to ask for them; in consequence of this a great number of unmarried women are to be found among them. When a marriage has been agreed upon, the father of the bride takes from the bridegroom an amount varying from Rs. 50 to Rs. 100. The Bheel women are very chaste. All the married women wear the "choli," or boddice, but an unmarried woman never does so. Among the Bheels the practice of woman-selling exists.

The following details were gathered at Dariawad, the chief of which place ranks amongst the second order of nobles of Meywar, 32 in number. The tribute or "chatund" as it is called, paid by the Rao to Oodeypore is 6 annas in the rupee (the value of which is 13 Government of India annas), and in the event of one of his ryots failing to pay in his share, the Rao takes possession of his cattle; should the ryot be still unable to pay, his daughter or daughters are seized until the claim is satisfied.

The only products which this country yields for export are gum and "ghee" (clarified butter), the market being Ahmedabad, which in return sends to the fair in February, held at Benesar Mahadeo at the junction of the Som and Mahi rivers, such necessaries of life as cloth, tobacco, cocoanuts and "gúr". The gum is principally used in dyeing cloth. The principal wood marts are Dungarpur and Banswárá to the south, Shalamgarh near Pertabgarh to the east, and Bhervi to the north.

On the northern bank of the Jákhum there is said to have been a very large Rathor city called Abisa; tradition says it extended from the Karmoli river to the Kairmalia hills, a distance of about 5 miles; this no doubt is a gross exaggeration, but at the same time old temples and heaps of bricks may be found more or less over this ground. From the fact of great quantities of bricks being found around the small village of Árbara, it would appear that the main part of the city was on the junction of the Súkli naddi with the Jákhum river. In the valley to the east of the Kairmalia hill is a very picturesque group of temples evidently connected with this old city. Bedawal ki Pál is also the site of an old Rathor city, and near this "Pál" to the south, are the remains of a fine old fort beautifully situated on one of the hills in the midst of the forest; this is known as Sálgarh. Other traces of the old Rathor inhabitants were found in these wild tracts, but these two are the most important.

Extract from the Narrative Report of H. Horst, Esq., *in charge No. 2, Khandesh and Bombay Native States Topographical Survey.*

Remarks on the country triangulated. Khandesh and Sátpuras,—Bombay Native States.

The country triangulated, *viz.*, 638 square miles, lies principally in Degree Sheet VIII, a part being in Degree Sheet IX. That below the river Tapti, or 493 square miles, is revenue-paying, and the remainder, or 145 square miles, north of the river lies in the Sátpuras. The former tract is hilly, the hills rising occasionally to 600 feet above the flat and cultivated ground. About half of this tract is only under cultivation, but not very productive, "*bajra*" and "*jowár*" being the principal crops raised. The Agra and Bombay road, still kept in good repair, intersects the tract, but the traffic is not great now since the opening of railways. It was considered advisable to triangulate this area closely, because it will be found inconvenient to run many traverses owing to the unevenness of the ground, and the detail survey will have to be carried on in the ordinary way to a great extent. The piece of triangulation in the Sátpuras is wild and mountainous, with few villages overrun with wild animals. On one occasion when returning to his camp, Mr. Graham was stopped by a couple of bears which made towards him, but the klassies coming up just then, raised a shout and the animals moved away leisurely. The principal villages in the triangulation intended for the 2″ survey are marginally noted, in all of which weekly markets are held.

Songir.	Chimtána.
Virdel.	Dhondaicha.
Wársa.	Nahlod.
Betáwid.	

Remarks on the country plane-tabled.

The country plane-tabled on the 2″ scale, lies between latitude $\frac{21^\circ\ 0'}{21^\circ\ 15'}$ and longitude $\frac{75^\circ\ 0'}{76^\circ\ 0'}$. It is intersected by the River Tapti, which enters it at the south-east corner and passes out of the north-west corner, and is cut up by several tributaries, *viz.*, the Áner, into which flows the drainage of the Sátpuras coming within the limits of Degree Sheet V, the Wágur, Bori and Girna, the Girna being the largest. On either side of the Tapti the ground is considerably broken up with deep ravines, especially near the junctions of the tributaries, which of course increased the labor of plane-tabling considerably; but for this, Degree Sheet V would have been completed during the season under report. There is not much of it remaining however, only about 35 square miles.

The principal towns and villages situated in the area plane-tabled on the 2″ scale are named in the margin. None of them can properly be classed as towns, but the first ten are very large villages. Yáwal alone has a masonry wall surrounding it, but fast falling into decay. The first seven, except Nasirábád, have Post Offices with Deputy Post Masters attached to them, and are connected by fair district roads. Bhusáwal, Nasirábád, Amalner and Chopra are the chief villages of the talukas of the same names and the head-quarters of Mamlatdars (a term equivalent to Tehsildar in the North-Western Provinces), but the Mamlatdar of Nasirábád resides at Jalgáon on account of its being on the Great Indian Peninsula Railway line. Yáwal is the chief town of the Peta (sub-division of a taluka), where the Mahalkari or Naib Tehsildar resides. He is subordinate to the Mamlatdar of Sauda in revenue, but not in judicial matters. There is also a sub-judge at Yáwal, as well as one at Amalner.

Towns and Cities.

Bhusáwal.	Arávad.
Nasirabad.	Kanalda.
Amalner.	Somwad.
Chopra.	Chávalkhera.
Yáwal.	Kingáon.
Dharangáon.	Dhanora.
Jalgaon.	Amalgáon.
Sákli.	Náuder.

In Khandesh a sub-judge exercises judicial powers over three or four talukas, and is subordinate only to the District or Session's judge; while over every four talukas there is an Assistant Collector. Bhusáwal is the name of the principal station of the Great Indian Peninsula Railway, and the point of junction of the Nagpore extension with the Great Indian Peninsula Railway main line. It is a flourishing place, and has been greatly improved by the company. It boasts of a nice public garden, and water is laid on to all the Railway buildings by means of pipes, the supply being obtained from the river Tapti, a mile to the north of Bhusáwal, raised by means of a steam-pump. It is the head-quarters of the Railway magistrate also. A company has lately been formed to utilise the water-power of the Tapti, and the requisite works will be established near the rapids to the north of the station. The company should prosper if economically worked, for the trade in cotton and flax is large. Jalgaon is another thriving place; it is situated on the Railway line, and has two cotton spinning and weaving mills, worked by steam. The cloth turned out is good and has nearly superseded the country manufacture. There is also a second class railway station and a dispensary with an assistant surgeon attached to it. An attempt is being made to construct a lake to the south of the village to supply water by means of pipes to the station; but it is feared it will not succeed as there is too much percolation. Dharangáon is the head-quarters of the Khandesh Bheel corps, commanded by Major O. Probyn. It is composed of Bheels, who are only entertained for political reasons, as they generally make wretched soldiers on account of their intemperate and indolent habits. In all the villages named in the margin there are vernacular schools, but the attendance is irregular.

In the Native States the principal towns which come within the season's operations are Rajpur, the capital of Ali-Rájpur, and Chota Oodeypore of the State similarly named. The former is under the jurisdiction of the Political Agent of Bhopáwar (Central India Agency) and the latter of Rewa Kánta (Baroda Agency). These towns are not protected by walls, nor do they possess forts. Like most native cities their sanitary arrangements are most imperfect, and it is always advisable to keep clear of them. The State of Ali-Rájpur is managed by a native Superintendent appointed by the Governor General's Agent for Central India.

Chota Oodeypore is situated on the right bank of the river Or, which is dry in the hot weather and is surrounded by very dense jungle. To the south and east, about 6 miles distant, there are pretty high hills. The town contains no nice buildings, nor is there any other attraction, not even that of sport in the surrounding jungle. A Post Office has lately been established as an experiment, which should succeed as there is none at Rajpur, nor at any of the neighbouring petty States. It was most convenient for the party, otherwise Katol, about 50 miles to the north, would have been the nearest place to post letters. The ancient capital of Chota-Oodeypur was at Mohan, in latitude 22° 3′ 49″, and longitude 74° 6′ 43″, a description of which was given last season by Mr. D. Atkinson, Surveyor, 2nd grade. The principal villages which fall in the season's operations on the 1″ scale are named in the margin. In the Ali-Rájpur State all, except Sondwa and Phulmal, are the head-quarters of Thanadars, a title equivalent to Tehsildar in British territory. Sondwa and Phulmal are the chief "jagir" villages, the Thakurs being relatives of the Raja. In the Chota-Oodeypore State, Kawant and Pánwar are the two most important villages as far as that State comes within the operations of No. 2 Party, and each is the head-quarters of a Thanadar, the parganas are similarly named. Káthiwára and Mathwar are the seats of two protected Thakurs, their "jagirs" being designated by similar names. The Thakur of Mathwar is a minor, and is obliged to reside at Indore for his education, while the State is managed by the Dewan, otherwise Superintendent of Ali-Rájpur.

In Ali-Rajpur.	In Chota Oodeypore.
Umráli.	Kawánt.
Walpur.	Pánwad.
Chaktalão.	Protected Thakurs.
Chaudpur.	
Amkút.	Káthiwára.
Bhábra.	Máthwár.
Sondwa.	
Phulmal.	

Along the northern boundary of the area plane-tabled on the 1″ scale, the southern slope of the Vindhyas stretches, and Rattan Mál, the highest western extremity, just comes within the overlap. This mountain is 2,146 feet above mean sea level at the point where the temple stands, and has been ere this, recommended for a sanitarium for Indore, as there is a fair-sized plateau

Hills and passes.

and plenty of good water; but the suggestion was never carried out, as it is considered malarious at certain times of the year. Along the southern boundary of the tract under description, the Nerbudda flows (part only coming within the season's operations) through a deep, narrow gorge, overlooked on either side by frowning precipices and high peaks, which are frequently inaccessible. The intermediate tract, *i. e.*, the country lying between the Vindhyas and the hills stretching along the Nerbudda, is composed of low ranges of hills with intermediate valleys, all inhabited and cultivated; and to the north of Chota-Oodeypore there are extensive jungles in which a few peaks rise abruptly to a considerable height, making admirable points for the plane-tabler.

Roads.

The principal lines of communication taken up or continued during the season under review are in the 2″ scale work from—

1. Malkápur in West Berar to Dhulia, *viâ* Nasirábád, Jalgáon, Dharangáon and Amalner.

2. Maijee to Bárhanpur in the Central Provinces, *viâ* Mhasawad, Jalgáon, Sauda and Ráver crossing the Tapti river by means of a ford or ferry, according to the season of the year, near Boráwal between Jalgáon and Sauda.

3. Dhulia *viâ* Amalner and Chopra, Dhoulid and Gada Ghati pass in the Sátpuras to Indore, crossing the river Tapti by ford or ferry, according to the depth of the water, at Nimgowhán, between Amalner and Chopra.

4. Bárhunpur *viâ* Sauda, Yáwal, Chopra and Thálner to Shirpur.

The above are all good *district* roads and are kept in fair repair. The Great Indian Peninsula Railway line also passes through the work and needs no remarks.

In the 1″ work comprising parts of several Native States, the principal roads are from—

(1). Rájpur of Ali-Rájpur *viâ* Umráli, Chaktaláo and Kawánt to Bhákar, which lies in work assigned to the Guzerát Party, Great Trigonometrical Survey.

(2.) Rájpur of Ali-Rájpur *viâ* Wálpur to Chaktaláo where it meets route No. 1.

(3.) Rájpur of Ali Rájpur *viâ* Umráli to Sondwa and Mathwar.

(4.) Rájpur of Ali-Rájpur to Chota Oodeypore and thence to Daboi, the terminus of the Gaekwar State Railway in work of Guzerát Party, Great Trigonometrical Survey.

(5). Chota Udepur *viâ* Pánwar and Kawánt to Háf.

(6). Rájpur of Ali-Rájpur *viâ* Khatali, Ghora and Bori to Sirdarpur, in work of No. 5 Topographical Party.

(7). Rájpur of Ali-Rájpur *viâ* Bhábra to Dhawad in work of No. 5 Topographical Party.

(8). Rájpur of Ali-Rájpur *viâ* Sorwa and Pánwar to Baroda in Guzerát.

9. Rájpur of Ali-Rájpur branching off in route No. 8 from Pánwar to Kalali in work assigned to Guzerát Party, Great Trigonometrical Survey. Of these routes, Nos. 1, 2, 4, 5, 6 and 7 are important (the others being of secondary note) and are practicable for wheeled conveyances.

Rivers.

The following rivers fall in the season's operations, but none of them are navigable:—

In 1-inch scale work.

1. Nerbudda, flows through south-east corner of Standard Sheet 28, about 6 miles, through a deep gorge overlooked by lofty hills which are very rugged and covered with dense jungle.

2. Hathni river, which enters the northern limit of work allotted to No. 2 party in Standard Sheet 26, latitude 22° 30′, longitude 74° 27′, and flows south-south-west, under Khatiáli in Standard Sheet 25; 8 miles south of which it takes a southerly course and enters Standard Sheet No. 28 in latitude 22° 7′, longitude 74° 30′; it joins the Nerbudda in latitude 22° 2′ 17″ and longitude 74° 29′ 43″. The Hathni derives its name from a rock at its source resembling an elephant.

3. Ankár river, takes its rise among some low hills in latitude 22° 18′, longitude 74° 10′, about 5 miles west of Rájpur, and after flowing south-south-east, joins the Hathni river about 3 miles north of its junction with the Nerbudda.

4. Heran, takes its rise near the village of Sagbara in latitude 22° 10′, longitude 74° 19′, and after flowing under Phúlmál and 1½ miles south of Pánwar in a westerly direction enters the work of the Guzerát Party in latitude 22° 7′, longitude 74°.

5. Kara, rises in hills 2 miles east of Gendra village, latitude 22° 3′, longitude 74° 19′, and passing Kawant joins the Heran close to Zelawat village in latitude 22° 9′, longitude 74° 1′.

6. Sukar, rises near Ikdari village in some elevated ground in latitude 22° 27′, longitude 74° 23′, and after flowing in a southerly direction as far as Rajpur, sweeps eastwards at right angles and joins the Hathni in latitude 22° 13′, longitude 74° 34′.

7. Or river, rises near Bhábra, the principal village appertaining to the pargana of the same name in the Ali-Rájpur State, from a plateau of the Vindhya range, and flows due south about 9 miles; then takes a turn at right angles westwards, which course it follows for 16 miles, when it diverges to south-west as far as Chota Oodeypore, whence it flows in a north-west direction to the limit of work, and enters the area allotted to the Guzerát Party in latitude 22° 20′, longitude 74°.

8. Ani river, rises close to Ratanmál mountain in the Vindhyas; enters northern limit of work in latitude 22° 30′, longitude 74° 8′, keeping a south-west direction till it runs into area allotted to the Guzerát Party and joins the Or river some miles off.

9. Bharej river, enters the northern limit of work in latitude 22° 30′ and longitude 74° 5′, and keeping a south-west direction, flows into work assigned to the Guzerát Party in latitude 22° 26′, longitude 74°.

In 2-inch scale work.

1. Tapti river, enters the present season's operations near Borawal, situated half-way between Nasirábád and Yáwal, and running with very little deviation almost due west, flows into Degree Sheet VIII under the well-known and ancient village of Thálner.

2. Aner river, rises in the Sátpuras, as already described in the report of season 1874-75, and joins the Tapti at Piloda village, at the trijunction point of the parganas of Chopra, Shirpur and Amalner.

3. Wághur, } All large tributaries of the Tapti, flowing into that river from the south; but
4. Girna, } as very small portions of these rivers have been surveyed, a proper descrip-
5. Bori, } tion of each will be given in a future report.

Inhabitants, their manners and customs.

The inhabitants of Khandesh in the revenue-paying portions being chiefly Mahrattas, need no particular notice in a report like this; those in the Native States under review are chiefly Bheels and Bheelalas (the latter being a cross between a Rajput and a Bheel woman). The Bheelalas are an industrious and a peaceable race, and are the principal cultivators. The Bheels, too, are quiet and orderly, except to the north of Rájpur in the Chandpur and Bhábra parganas of Ali-Rájpur, where they are considered a murderous and treacherous lot, requiring all the tact and energy of the Dewan to keep them in order. All go about armed with bows and arrows, and at 50 yards they are dead shots, of which abundant proof is present in the country being almost totally devoid of game, although covered with jungle and fairly well watered. At 20 or 30 yards a Bheel will send his arrow, of which the shaft is 6 inches long, being flat, and the edges as sharp as a razor, right through a leopard or a bear. This was done last year on three occasions. The people of Máthwar are exclusively Bheels and no better than savages. The men are perfectly nude and the women wear only an apron consisting of three or four "*dhak*" leaves, but are laden with trinkets of all descriptions from their heads to their loins, and from their knees to their toes, their arms and fingers being similarly decorated.

Sheik Omar, Sub-Surveyor, who surveyed Máthwar and the Nerbudda, as much of it as fell in the past two seasons' operations after it enters the hills, says: "there is a certain class of mendicants or Gusains, styled Parkama Básis, who commence their pilgrimage from any shrine on the Nerbudda, travelling up one bank as far as Amarkantak at its source, and down the other to its mouth near Broach, where they cross over and return to the same shrine whence they started, when they recommence the same journey, always keeping close to the water's edge, and drinking no water but that of the river. The Bheels who dwell on the banks of the Nerbudda, particularly those of Dasana in the Dahi State, have a great aversion to these mendicants, whom they rob and seize, when they can do so with impunity, and after making them stark naked, force them to jump and dance for their amusement on the hot sand, touching them up with their arrows if they hesitate, and wounding them rather severely at times; the Bheels being under the effects of liquor or toddy show little mercy."

Sorcery among the Bheels.

Incredible accounts are given of the Bheels practising sorcery during the "*Holee*" and "*Dusera*" festivals, for instance, walking through the fire and not being burnt; holding a red-hot bar of iron in their bare hands and licking the same without hurting the tongue; taking a rupee out of a pot of boiling oil, and the like. The first, *viz.*, that of walking through the fire and not getting burnt, came under observation oftener than once. On the 5th April, when encamped at Kua village in the Amkhát pargana, appertaining to Ali-Rájpur, Mr. Horst was told by Mr Graham of certain Bheel priests who could make people go through fire. They were accordingly sent for and after a great deal of persuasion and the offer of a rupee they very reluctantly consented, affirming that the time was inauspicious. A hole about 4 feet long and 18 inches wide and the same in depth was dug, and after being well heated was half-filled with live coals. The "*pujari,*" or priest, then muttered some incantations and fanned up the coals till they were quite bright and glowing; he then killed a fowl as a sacrifice and waved a naked sword six times over the fire, after which he told a Bheel sitting beside him to walk through the fire, which he did, treading six times deliberately, and repeated the operation three times. Suspecting some trickery, the soles of the man's feet were examined, but they were not burnt or blistered in the least. A Mahomedan chaprassi, native of Oudh, who happened to be standing near, was asked if he would venture to walk through the fire. He replied "yes, because there is a charm over the fire and it can't injure me," and without the least hesitation he went through, moving 6 inches at a time and very slowly. On examining his feet, it was found the flesh was not even singed. The Dewan of Ali-Rájpur assured me it was a common practice and frequently adopted by village "*punchayets*" for trials of theft and murder.

Products, soil, cultivation, &c.

In the area under report in Khandesh, no products or manufactures worth mentioning, except that of cloth at Jalgaon already alluded to, came under notice. The country produces the ordinary cereals, but in consequence of the drought the crops were few and very scanty. Cotton is

usually grown in large quantities, and the trade in favorable seasons is brisk. There was not even sufficient grass for cattle last season, and consequently large herds were driven into the Sátpuras as early as November and December for pasture, during which months the climate is deadly and the result was, that the owners or herdsmen were stricken down with jungle fever, numbers dying and others being prostrated for months. In the latter part of January there was heavy rain throughout the district of Khandesh, but unfortunately too late to be of any benefit, excepting that the water-supply was increased. In the Native States under review, "bajra" and "jowar" are the only crops, and sufficient only for local consumption. The palmyra palm is extensively grown for its toddy, which the natives partake of in large quantities, and during the season, *viz.*, in March and April, they are in a continual state of intoxication. The people are extremely poor, particularly in the Chota Oodeypore State, where assessments are much heavier than in the neighbouring one of Ali-Rájpur. The soil on the revenue-paying portions of Khandesh is black cotton, very productive during a fair season of rain; whereas in the Native States it is stony, though every available spot is ploughed up and crops grown on it.

Extract from the Narrative Report of CAPTAIN T. H. HOLDICH, R.E., *in charge No. 3 Topographical Party, Central Provinces and Vizagapatam Agency Survey.*

Remarks on country plane-tabled.

A description of the country plane-tabled would be merely a recapitulation of the description of the country triangulated last year. But in such a wild, rugged, tract as this, such an untrodden land of promise to the explorer, antiquarian, ethnologist or sportsman, there must be many points of deep interest which cannot be touched on in a report of field operations, which comprises, at the best, merely a superficial examination of the surface of the ground and deals almost exclusively with the configuration of hills and valleys. The archæologist, ethnologist or naturalist, who carefully follows up his science into the high-ways and bye-ways of such a wilderness as this, would find his time fully occupied with his own special hobby, and the business of the surveyor is rather to make the map which may help others to arrive at a comprehensive knowledge of the land and of the manners and ways of the people. To the sportsman only, it may be worth while to point out that the hills and valleys of Bastar immediately south of Raipúr, which can be approached by the Raipúr and Dhamtari road, seem to be full of large game of all descriptions, and with the map in his hand no sportsman would find much difficulty in making his way about this part of the country with carts. A more general description of the whole area embraced in the season's operations I will leave to Mr. May, who is well qualified to give it.

Note by MR. J. A. MAY, *Surveyor, 3rd Grade, on the ground surveyed by No. 3 Party,— Season 1876-77.*

Petty Native States, Central Provinces.—Bastar.

In describing the country surveyed during the past field season, I can add but little of interest to that which has already been written by Captain Holdich in his Narrative Report of season 1875-76; but as he has expressed a wish that I should give a description of it, having, while on my tour of inspection through the several plane-tables, had an opportunity of ascertaining personally the character of the ground, I will endeavour to do so to the best of my knowledge, though it is almost impossible to render an adequate idea of a country so little known and so difficult of access, where information is obtained with the greatest difficulty, and the time necessary for enquiry and investigation is of so short a duration.

The portion of the Bastar district in which the party was engaged, lies between the parallels of 19°0′ and 20°15′ north, and the meridians of 80°30′ and 81°30,′ and embraces the taluks of Narainpúr, Pertabpúr, Parlakot and portions of Dongar, and Chota Dongar, the characteristic features of which are extensive plateaux of from 1,800 to 2,000 feet above sea-level surmounted by masses of flat-topped hills, which rise to elevations exceeding 3,000 feet, the culminating point being the commanding hill of Asnar, misnamed Hachel in the triangle sheets, situated in the taluk of Chota Dongar. These high lands are a continuation of the great plateau system of Central India, which decreasing in elevation by a succession of steppes, finally break to the west into the low-lying plains forming the basin of the Godavari. A marked fall, scarped, and attaining a great altitude, in some places intersects the ground diagonally, constituting the western limit of the elevated plains above mentioned, and gradually becoming less abrupt to the south loses itself in the low irregular hills between the Indravati and Kotri rivers. The geological structure of this part of the country is of a varied and mixed kind, being composed of trap and varieties of sandstone and slate; the first occurs in the higher flat masses, while the two latter predominate in the lower hills and are distinctly separate from one another, a circumstance producing the bold, rugged and ever-changing scenery which would be pleasing but for the dull, heavy, sameness of the endless forest that completely clothes the ground from the plains to the summits of the highest peaks.

The climate of the plateau, though unhealthy during a greater part of the year, is by no means unpleasant in the hot months, and especially delightful in the months of December, January and a part of February, while the plains are tolerable during these latter months, but unbearable in the summer, the thermometer rising sometimes to 110° Fahr. under the awning of a tent. Drought is seldom, if ever, experienced in this part of the country, as the

rains commencing early in April, last till late in November, and not unfrequently, as it happened during the field season, to the end of January.

Several important streams drain the country, of which the chief are the Kotri, Nibra and Barda. The Kotri or Parlakot river is the largest, and forms for a great part of its course the boundary between Chanda and Bastar. It has the well-known villages of Pertabpúr and Parlakot situated on its banks, and after a considerable course through heavy forest in the plains, flows into the Indraváti at Bhámragarh. In the dry season these rivers are fordable at most points, containing little or no water, except where higher levels or other impediments obstruct the too rapid draining-off of their surplus water. In such localities the water obtains to great depths, which often offer serious obstacles to the Surveyor; and it is in these places that the most picturesque scenes are to be met with. The water is generally still and clear; the banks lined on either side by the most luxuriant foliage, with broken masses of rock scattered in wild confusion, and sometimes rising in a precipitous wall from the water's edge to great heights, all charmingly reflected in the calm limpid element below, make up a picture truly beautiful. Such are the favourite retreats of the larger game in the country, where the lord of the hills—the formidable bison—and his stately though less active compeer—the buffalo—withdraw during the heat of the day to refresh themselves, and where the "*pugs*" of the tiger follow on the track of his much-coveted prey whom he dares not attack openly.

In the greater part of this wild and hilly region, the villages are scattered and sparsely populated, and in many instances totally deserted for several miles in extent, the only portion worthy of notice being the taluk of Narainpúr, in which a few fair prospects, like oases in the desert, gladden the eye, and which is especially the case round and about the village of Narainpúr, itself situated on the plateau, surrounded by some of the finest patches of cultivated land in the country. It contains a mixed population of Murias and Halwis, of about 450 inhabitants, and lying on the route between Chanda and Jagdalpur, seems to be a prosperous and flourishing village. This village together with Pertabpúr, Antagar, Kolur, Amabera, Govadi, Parlakot, Dongar and Sonpur are about the principal villages in the season's work. Of these, Dongar perhaps is the next in importance to Narainpúr, and is situated also on the plateau at the foot of the rocky range of the same name: it contains about 200 inhabitants, and is remarkable for its numerous tanks in and without it, which are supposed to be 100 in number, each having a distinguishing name. These tanks, merely small ditches and ponds, most of them being omitted in the map owing to its small scale, give an importance to the village of which the people seem very proud, and to which no doubt some legend or historical event is attached.

The village of Pertabpúr is situated in the plains on the right bank of the Kotri; it is a respectable and apparently well-to-do place, the residence of a petty Raja, and the chief village in the Pertabpúr taluk. It would be as well to remark that the taluk of Pertabpúr, as well as the adjacent "mutah" of Antagar and the taluk of Parlakot, offer one of the finest fields for the sportsman. Tigers seem literally to abound here, Mr. Claudius having shot several of these destructive animals in the short space of time he was employed in it. Great damage is done by them to the cattle, and sometimes whole villages are deserted owing to their depredations. A somewhat unusual circumstance occurred during the field season in which some bullocks attached to the several Surveyors' camp were taken away in broad daylight and in the presence of their owners. Adventures with the tiger are of frequent occurrence in this part of the district, and a singular tale was recounted to me by Mr. Claudius who was close to the spot where it happened. A villager, while bathing at a stream, was startled by a noise at the back of him, and on turning round to ascertain the cause, to his great horror, beheld a tiger in the act of springing on him; his presence of mind, however, did not desert him, and picking up his wood-axe dealt the tiger a blow, burying the blade, which was about six or seven inches in length, in the animal's head; a short struggle ensuing, the man called out for assistance, and with the help of a few others despatched his enemy who was most probably in his death-throes at the time.

Parlakot is a small straggling village, also on the right bank of the Kotri and in the taluk of the same name. A petty Raja resides here who is of the Halwi caste, a very hospitable young man; he has always shown a willingness in assisting travellers on their way through his "*Raka*," which is about the poorest in the ground, embracing a large portion of the plains to the west and flanked by the rugged, broken and desolate hill tract to the east, has a most uninviting prospect, and is a fitter abode at present for the denizens of the forest than their more rational congeners, the semi-barbarous tribes that inhabit the district. The main routes giving access to the interior and to the capital of Bastar from the west are three in number. Starting from the station of Chanda, a road leads through Pertabpúr, Kolur and Narainpúr to Jagdalpúr, and the other two from Ahiri, the one passing through Bhámragarh to Narainpúr, and the other through Parlakot, ascending a tediously long but easy ghát, leads to the same point. The first and last mentioned are practicable almost throughout to carts; other minor tracks branch from these and lead northwards to Dhamtari in the Raipur district and south to Byramgarh and Kutru, in the area surveyed last season. The tribes composing the population of the country are the Halwi and a section of the Gond family, called Maharias or Murias. The former seem to be a sect of Hindoos, settlers from the Central Provinces of Raipúr and Bilaspúr; they are an intelligent people, dress well, and are generally land-owners. Their language is a kind of Hindustani which sounds pleasant to the ear. Their customs and rites are simple and common to other Hindoo races, in which there is nothing remarkable. They barter for their wives, and their dead are usually burned. The Maharias of the hills or the Murias of the plains are in every respect like their brethren the Kois and Gotwars, having the same rites and ceremonies which are in some instances modified by contact with other races.

They are a hardy, simple race of people, extremely shy and reserved, which is especially the case with the hill Maharias, who, as Captain Holdich has remarked, make very untrustworthy guides, in which capacity their only object is to get rid of the traveller at the first village they come to, whether that village be on the proper route or not, and it was owing to this circumstance that communications were so difficult to maintain during the past field season. It was not an unusual thing for our messengers, who ignorant of the language spoken by this wild people, which is sometimes unintelligible even to those who have resided in the country for years, to be guided back to the place whence they started, after rambling about the country for a whole month and without having attained the object with which they set out, though the time it should have occupied them with proper guides ought not to have exceeded a couple or three days.

Among their festivals I witnessed a dance which is performed in celebration of the new year, and which takes place in the month of February. A number of men fantastically dressed for the occasion with peacocks' feathers, beads and parti-colored rags, and having small drums attached to their waists in front, form a ring round the women, who, with linked arms, sway to and fro, clapping their hands to a monotonous ditty, within the circle, while the men move round, oscillating with measured steps from side to side, something similar to the movement in the mazurka, with remarkable regularity and precision, which they vary at the command of one of them, who constitutes himself the master of the ceremony, beating their drums in accompaniment. This dance is, I believe, peculiar only to these people, as I have never heard of it in any other part of the Central Provinces. I also noticed a circumstance connected with their funeral rites, which has been mentioned in previous reports, but the truth of which was not established before. On several occasions I remarked the charred appearance of certain trees, and on enquiry learnt that the custom among the Maharias is to fasten their dead to a tree which is usually the "*Bassia latifolia*," and piling combustibles around reduce the body to ashes. Large rough slabs of stones buried perpendicularly by the roadside mark the last resting-places of the ashes of the deceased, and are the only memorials of the kind to the north of the Indravâti.

The produce of the country is the same as elsewhere in Bastar, and has been given in my notes of the country of last year. The teak of previous seasons has given place to the "sâl," which is to be found covering extensive areas, whilst the teak is met with in small isolated patches distinctly apart from the other, a remarkable feature in the distribution of these trees, the former preferring localities where the aqueous formation is apparent, and in the latter in soil composed of trap and other igneous and metamorphic rocks.

A few old forts curiously perched on the tops of hills and of very ancient date exist, one on a hill close to the village of Parlakot, and another on Binapal Hill Station. In the "mutah" of Antagar, with one or two others, are the only archæological remains the country possesses, of which nothing relative to their history was obtainable.

Extract from the Narrative Report of LIEUTENANT-COLONEL G. C. DEPREE, *Deputy Superintendent, in charge No. 4, or North-Eastern Division, Central Provinces Topographical Survey.*

The last Narrative Report.

Since, therefore, this narrative report of the No. 4 Topographical Party is the last which will be submitted, and since I have been associated with the party from its organisation up to the present time, a period of 22 years, I venture to think that a brief history of it may not be here out of place.

Organisation of the No. 2 Party, Ganjam Survey.

This party was organised by myself in 1856. The old Madras Topographical Survey quartered at Cuttack being divided into two parts, one-half the party became the nucleus upon which was formed a complete party called the No. 2 Ganjam Topographical Party, and it recessed at Cuttack.

Names of officers in charge.

The organisation having been completed early in the year 1856, Mr. John Dyer, Great Trigonometrical Survey, was deputed from Mussoorie to assume charge, and to take it to the field in the Sambulpur district. Mr. Dyer was however soon transferred to a civil appointment in 1857,

Captain G. H. Saxton.

and Captain G. H. Saxton on return from furlough held charge, from September to October 1857. From that time up to the present date I have held charge, with the exception of fifteen months in 1858 and 1859, and of two years from 1868 to 1870.

Quartered at Cuttack.

From 1856 to 1860 the party retained the old name and number, and remained quartered during the recess at Cuttack. It was constantly employed in detail surveying, except in 1858, when the state of the country consequent on the mutiny rendered it unadvisable to enter the Kolhan; it was instead ordered to lay out and observe a series of triangles for the purpose of defining the coast line of the Bay of Bengal, a work which had been abandoned by the Coast Series party of the Great Trigonometrical Survey.

Employed on the triangulation to define the coast line of Bengal.

Mr. J. O. Nicolson.

In the year 1858-59 Mr. J. O. Nicolson, Civil Assistant, was transferred from the Great Trigonometrical Survey and appointed to the charge of the party during my absence on sick leave.

Party transferred to Dorunda.

On my return the Cuttack Division having been completed and that of Nagpore being in progress the recess station was changed from Cuttack to Dorunda, the military station of Ranchi, and the name of the party was altered to the No. 4 Topographical Party, Chota Nagpore "Division Survey."

The detail survey of the Chota Nagpore Division, including the Tributary States belonging thereto, continued to be systematically mapped until completion in the year 1870.

Lieutenant M. T. Sale.

During the two years 1868-70, Lieutenant M. T. Sale, R. E., was appointed to hold charge of the party during my absence in England.

Party transferred to Mussoorie.

Name changed.

In 1870-71 the survey of the State of Sohagpúr of Rewah, and of the Mandla district, and of parts of the districts of Bálághat and Bilaspur was taken in hand, the party being ordered to recess at Mussoorie. The name of the Party was again changed to "No. 4 Topographical Party North-Eastern Division, Central Provinces Survey."

Transferred to Simla.

In 1876-77 the remaining area of the Central Provinces was completely mapped, and the party already reduced to nearly half strength, has been transferred to recess quarters at Simla, where it will be amalgamated with the No. 7 Topographical Party, and the name of the "No. 4 Topographical Party" will cease to exist from 1st October 1877.

Area of country surveyed during 1856—1877.

During the 22 years of its existence, the No. 4 Topographical Party has triangulated and mapped on a scale of one inch to one mile, a tract of country extending from the high-water mark of the Bay of Bengal at Balasore to a point nine miles east of Jubbulpore. This tract extends for nine degrees of longitude, and on an average for two degrees of latitude, and its area aggregates nearly 52,000 square miles.

Description of country surveyed.

This area consists of country hitherto unsurveyed, except only the States of Sohagpúr and Ramgarh, mapped on a small scale in 1841 by Major Wroughton.

Description continued.

The difficulties overcome have been of no ordinary nature; for the tract of country is a continuation of the Vindhyá range which crosses India from Bombay on the west towards Calcutta on the east and thence turns southwards to Madras, forming everywhere the watershed between the great river systems that run into either the Bay of Bengal or into the Indian Ocean about Bombay. The land is almost entirely a series of plateaux of one uniform height of between two and three thousand feet above sea level, the highest point rising to a little over 4,000 feet, and the lowest, the bed of the Nerbudda river near Jubbulpore, to about 1,300 feet. The whole tract is wild, hilly and inaccessible, for it is destitute of roads, and it is inhabited by an aboriginal population of Koles and Gonds, including many different minor tribes. Except where small communities have cleared spaces for cultivation around their villages, it is covered with heavy forest, where wild animals abound and malaria is ever-present.

Large-scale surveys.

In addition to the survey of country on the one-inch scale, eleven Government reserved forests have been mapped on the four-inch scale.

Names of divisions, districts and States surveyed.

Besides sundry outlying portions of the Cuttack Division and of the Central Provinces, the following States and districts have been surveyed :—

List of Districts and States surveyed by the No. 4 Topographical Party between the years 1856 and 1877.

Division.	District.	State—Pergunah.
Chota Nagpore	Singhbhoom	Kolhan.
		Kharsáwa.
		Porálát.
		Saraikela.
		Dhalbhoom.
Ditto	Chota Nagpore or Lohardugga ...	Chota Nagpore.
Ditto	Tributary Mehals	Bonai.
		Chang Bhokar.
		Gangpur.
		Jushpur.
		Korea.
		Udepur.
		Sirgooja.
Raipur	Bilaspur	Korba.
		Uprora.
		Mátim.
		Lafa.
		Churi.
		Pendra.
		Kenda.
		Kori.
		Pandariya.
		Kawarda.
Rewah	... ...	Sohagpúr.
		Singwara.
Nagpore	Bálághat	Kini.
		Bhánpur.
		Bijagarh.
Jubbulpore	Mandla.	Chauria and others in part only.
	Rámgarh.	

Alphabetical lists and villages.

Alphabetical village lists have been compiled of each State, areas calculated, and the number of houses counted, and the whole arranged in a compendious form as a Gazetteer for each of the Standard Sheets. The Chota Nagpore Division survey covers seventy-five Sheets of 30′ longitude by 15′ of latitude; and the North-Eastern Division, Central Provinces Survey forty-two. The full details of Sheets Nos. 1 to 23 have not been arranged with the completeness of subsequent Sheets, but total areas and numbers of villages, &c., have been calculated for the several States, *vide* printed Report, Geographical and Statistical, of the Chota Nagpore Division and Singhbhoom District by Captain G. C. Depree, dated July 1868.

Number of Standard Sheets of the Chota Nagpore Division and of the North-Eastern Division, Central Provinces Survey.

Names and nature of the country surveyed.

The country surveyed consisted principally of the Bálághat district, of a small part of Bilaspur on the south, and of Mandla district on the north. Without any exception, it was hilly, difficult and thinly inhabited; the part to the south contains only about 17 souls to the square mile. The Revenue Survey had previously surveyed all the low, well-cultivated country, the limit of their work being conterminous with the hilly, bad ground, which in consequence fell to the share of the Topographical Survey.

Pándra-tola forest.

The Pándra-tola forest was finally surveyed, thus completing the series of reserved lands in the Central Provinces, which have fallen within the area of ground undertaken by this party. These forests number eleven in all. The forest in question consists of a narrow strip of land bordering the left bank of the Wainganga river in the Bálághat district. It consists of small teak forest and of irregular ground, a good deal cut up with water-courses, and otherwise not susceptible of cultivation. The area is 4,817·0 acres or 7·5 square miles.

The water shed of India surveyed.

The country delineated on the south continues as a part of the backbone of India. In Sheets Nos. 33 and 34, &c., the streams on the north are affluents of the Nerbudda, and those on the south run into the Wainganga, which two rivers enter the sea on opposite sides of the Peninsula.

Definition of boundary between the Mandla and Bálághat districts.

The boundary line between the south-west of the Mandla district and the north of the Bálághat district has long been a standing difficulty, owing to its passing over a very difficult, deserted and inaccessible country. In 1875-76, a Deputy Commissioner and an Assistant Commissioner were deputed to define this boundary with permanent marks, but they eventually left the ground without effecting any thing. Meanwhile, the country in question had been finally mapped by this party, and the true boundary duly surveyed. In order that the opportunity of defining the boundary on the ground might not be lost, and to prevent further uncertainty, I offered to go over the boundary, and affix permanent marks. The Chief Commissioner, Central Provinces, was pleased to accede to my offer, and the work was accordingly carried out with an expenditure of nine days' labor. The boundary-marks thus fixed have been entered on the Survey maps.

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Extract from the Narrative Report of Captain J. R. Wilmer, B. S. C., *in charge No. 5 Topographical Party, Bhopal and Malwa Survey.*

The Vindhyá range runs generally east and west through the centre of the portion surveyed, and varies considerably in conformation, at one part being well marked and narrow, at another very precipitous and broad, and at another very much broken up. Throughout its length it is covered with forest jungle. This season nearly completes this remarkable range. It has been carried on to the west by the Khandesh Survey. A portion of it again enters our work further west. Three water falls, showing the abrupt nature of some part of the scarp, were met with this year in Mr. Hamer's and Mr. Wainright's portions. Two of them were measured by me and found to be 200 feet and 430 feet in actual drop, the rope for measuring the depth being only at arm's length from the point where the water fell. The rope, with stone attached went to the bottom without anywhere touching the rocky wall. The third was 350 feet deep, as measured by the falling of a stone to the water beneath. On looking from the scarp of the range to the south and over the valley beneath, it looks like one flat sea of a dense forest jungle, with but a few low hills to relieve the monotony; not another feature of any kind can be seen, not even does the Nerbudda anywhere show that it is in existence. The Valley of the Nerbudda to the north of that river surveyed this season, consists of flat country, covered with dense forest, tall trees, breaking up into deep ravines near the river-bank. That portion belonging to Dhar territory bounded on the east by the river "Khári" and on the west by the "Kánár" is exceptionally wild in its nature and almost uninhabited, and only frequented by wood-cutters that seem to come from all parts of the country when out of employ, to cut timber which they sell at Indore. There is only one outlet for them from this piece of wild country and that goes through "Kila Mohára" gate, where they have to pay toll to both the Indore and Dhar States on each bullock-load of wood. The forest does not appear to be in the least taken care of, and yearly the grass is burnt down to strengthen the new grass for grazing purposes during the rainy season. The fire must destroy all the young plants before they have time to grow.

The trees of these forests are tall: sometimes exceeding 110 feet: the names of some of the trees to be got there are:—

Ebony,	native name	"Tendu," yields a sweet fruit in May or April.
Teak,	„ „	"Anjan," timber wood.
	„ „	"Ságon," timber wood.
Bengal Quince	„ „	"Bel," fruit is medicinal.
	„ „	"Mohwa," flowers fall in March; spirit extracted.
	„ „	"Baher," the nuts yield a yellow dye.
	„ „	"Al," yields a red dye.
Indian cotton tree	„	"Semal," tree yields a gum; part of the flowers are eaten by the natives; the cotton used for stuffing quilts.
	„	"Gúlar," fig tree.
	„	"Bija," timber tree.
	„	"Sáj," ditto.
	„	"Kohu," of little use.
	„	"Kuin," of no use.
	„	"Salai," pitch made from its resin; also "Khair," "Jamlasi," "Astra," "Phási," "Chironji" (fig), "Gorár," "Gubdi," "Malsajur," "Sájur" and others of less importance.

City of Dewas.

Dewas city has an area of about half a mile square, is divided into two divisions, belonging to Rájá Kishanrao Paowár and Rájá Náraindrao Paowár (or Bara and Chota Pánti), and is situated to the south and at the foot of an isolated hill north-east of, and 24 miles from Indore, and on the Great Deccan Road, between Bombay and Agra. The hill is remarkable as being a sacred shrine belonging to the goddess "Chámandi." A road is being laid down from Dewas to Sehore; a portion of it has been surveyed this season; the remainder had not been laid out when that part of the country was being surveyed. There is a post office and rest-house at Dewás.

Rivers.

A portion of the Nerbudda forms our southern boundary, and has in part been already described. Opposite the village of "Dhári" there is a considerable rapid having a drop of about 15 feet. There is also a waterfall near "Jinerám" village, having a drop of at least 20 feet; the whole volume of water here falls into a deep narrow channel, only a few yards wide. This river is, except at the ferries noted below, only navigable by canoes, each of which is cut out of a single tree. Other rivers are the "Khari" and "Kanár," east and west boundary of Dhar territory. The "Datni," "Chandkesur" and "Chural," all have their sources in the Vindhya range and flow into the Nerbudda.

Ferries and fords.

There is a ferry of one boat opposite the village of Rájodi. A much frequented ferry between Futegarh and Joga of three or four boats. This is the line of communication which connects the G. I. P. Railway Station of Harda with the Nimáwar pergunnah, and by which the surplus produce, chiefly grain and oil-seed, of that pergunnah is conveyed to Bombay. A ferry between "Dharanpur" and "Panghát." A ferry at Dhári above the waterfall, being the line of communication to Pánára. Ferries at Rampura and Bakatgarh; these ferries are used for conveying wood across from Pánára forest on south bank of the river. A ferry from Kotah to the well-known island of Unkárnáth. There are fords at several points of this portion of the river; but these are only fordable in the dry weather.

The inhabitants north of the Vindhya range are of the same class as those met with last season.

Product, soil and cultivation.

Opium is much grown north of the Vindhya range; also cereals of sorts. On the sandy islands of the Nerbudda a good deal of the castor-oil plant is grown. The portion of the valley of the Nerbudda surveyed this season is very scantily cultivated, and only sufficiently so for the consumption of the few inhabitants that live there.

Report on country triangulated by LIEUTENANT ST. G. C. GORE, R. E., *during Season 1876-77.*

The ground triangulated during season 1876-77 lies between the parallels of 22° 30′ and 23° 30′, and the meridians of 75° and 75° 30′. It comprises the greater portion of the Dhár territory, the Amjhera district of Gwalior territory, portions of the Ujain district of Gwalior territory, and part of the Ratlám and Sclana territories.

Physical conformation.

The range of the Vindhya hills continues to form the southern boundary of the work. In most places they do not project above the level of the plateau to the north, and consequently when viewed from the plateau they merely present the appearance of a few small isolated hills. It is not until one is quite at the edge of the plateau that the broken character of the ground appears. Mid-way between the towns of Dhár and Amjhera there runs a low ridge which extends northwards some 30 miles. The point where this ridge emanates from the Vindhya range is the water shed of three of the river systems of India. On the south runs the Nerbudda. On the north-east rise the Chambal and Chamli rivers, which, uniting near Barnagar, run down into the Jumna. To the north-west rises the Mahi river, which, after running towards the north, bends round towards the south-west, and, after draining a large extent of hilly country, empties itself into the head of the Gulf of Cambay. The above-mentioned ridge is composed chiefly of basalt, and is remarkable for the number of constantly running streams which rise on its western slope and empty themselves into the Mahi. The country along the banks of the Mahi river is very much broken up, and in parts covered with heavy jungle.

The staple product is, as is usual throughout Malwa, opium. A fair quantity of grain is however grown, especially in the Dhar territory.

Cultivation.

A considerable quantity of the opium was this season entirely destroyed in certain districts by a heavy hail-storm which fell on the 7th February.

The only inhabitants who call for remark are the Bheels, who live in the broken ground on the banks of the Mahi. They are apparently very timid, and often desert their villages when one approaches. Their reputation for honesty is not great.

Inhabitants.

The only large towns which were met during the season were Dhar and Rutlám. Dhar is situated among a number of low hills, from which it is completely commanded. There is a well-built but very old-fashioned masonry fort flanked with numerous towers. It stands immediately to the north-east of the town on a small isolated hill. If properly defended, it would be impossible to take it by assault without previous bombardment and breaching. At present there is an unrepaired breach on the south-west face, which is however not quite practicable.

Principal towns.

Rutlám is a large and thriving town. The principal streets are broad, clean and well laid out. It is a very favorable specimen of an Indian town, and has a well-cared-for appearance, due I believe to the exertions of the Political Agent, Mir Shahamat Ali. The Holkar and Neemuch State Railway is to pass through Rutlám, and is in a fair way towards completion up to that point.

The cantonment of Sirdarpore also lies in the season's work. It is situated in the Amjhera district of Gwalior territory, and is the head-quarters of the Malwa Bheel Corps.

Extract from the Narrative Report of the Naga Hills and Lakhimpur Expedition Survey Party, by LIEUTENANT R. G. WOODTHORPE, R. E., *Assistant Superintendent in charge.*

On the 12th January 1877, Mr. Ogle and I left for the Tenga Pani. We arrived at the mouth of that stream the next day, and on the morning of the 14th reached Latao, the first Singpho village we had seen. It is a comparatively large one containing 30 houses, 8 or 10 being the general average. The headman we were told had gone across to Ningro Saman's village, Munglang, on the Noa Dihing, expecting to meet us there; but in his absence his wife did the honors of the village, and paid us a visit shortly after our arrival, dressed in her best, and attended by other women and several of the more important men of the village, and presented us with rice, fowls and eggs. We made enquiries about the hill, and were told it was close by, so we went off to see it. It turned out that the interpreter thought any little rise would satisfy us, and we found ourselves conducted to a low knoll, the end of a long spur from Manabum. Explanations ensued, and we learned that our best way of getting to the ridge was to go up the river about two hours' journey, when we should find a spur running down to the water's edge which would guide us to the highest point on the range. We left Latao the next morning, and found the spur as the Singphos had said and commenced to explore it; the thick canes and bamboo jungle impeded us much, and the tracks of wild animals crossing each other in every direction were very perplexing; so even with the counsels and assistance of our Singpho friends we made but little progress, and the evening found us still far from the hill, having only gone ¾ mile from the river. A Duania who was with us and a Khasia climbed up a tall rubber tree with surprising dexterity, but the highest part apparently only commanded a view of the neighbouring jungle, and they came down without any better idea of the direction we ought to take; so we returned to our camp on the river for that night.

The next day we resumed the trail, and at mid-day were rewarded by finding ourselves on the range, and water close by. Our coolies set to work; but several hours' hard work made but little impression on the thick bamboo clumps and trees of great girth that covered the hill; the next day we took up all our coolies with light baggage and encamped on the top, and there we remained for ten days, selecting and clearing points and building ladders up tall trees only to find, when we reached their topmost branches, that our labor had been vain, and that we must seek elsewhere for our stations. We had several good climbers among our coolies and klassies, and we used to send them up the highest trees to report on the view from them before commencing any operations. The range is nearly level along the top with no commanding points anywhere; it is sinuous, and covered everywhere with tall forest trees filled in with tangled undergrowth of bamboo and cane, through which we cut at the rate of 300 yards an hour, and much useless labor was expended by frequently following what seemed to be the ridge, but which turned out after a couple of hours' cutting to be only a spur. We found it would be impossible to get two suitable points for stations, and confined ourselves to one we had fixed upon at the first, and at which our coolies had been working for some time. When the platform had been built in a big rubber tree at a height of 108 feet from the ground, a magnificent view of all the hills surrounding the head of the valley was obtained; the lofty snowy peaks rising immediately behind the outermost ranges looked so close that we could almost fancy we could throw a stone on to them. Notwithstanding the fine elevation of our platform, we were still under the necessity of cutting down big trees a quarter of a mile off on obscure spurs before we could see all we wished. We got the mark up and all our observations finished by the 27th, when we again moved camp and went in to Sadiya on the 28th to make our arrangements for carrying on our work on the Noa Dihing and also to see Colonel Graham, the new Deputy Commissioner, who had gone to Sadiya for the "*mela*," which took place on the 31st January and 1st and 2nd February.

Our correspondence, observations, &c., detained us at Sadiya till the 6th, when we again left for Noa Dihing Mukh, where we had a godown built, and all the supplies we should require up to the middle of April, stored. From this place we went on to Wakidgáon, arriving there on the 10th February. Our intention now was to get up to Captain Samuell's points of Honkap and Máum and extend his triangulation eastward. Honkap was not visible from Sadiya or Manábum Hill Station, but Máum was; and this point we intended to connect with the two former. The headman of Wakidgaon was away, but his deputy gave us an empty house at once as a godown, and in this the "*russód*" we had brought in our boats was stored, the boats being sent back to bring up the rest, as our journey was to be overland from Wakidgaon *viá* Bisa, for which place, taking one month's supplies with us, we left on the 11th, reaching it on the 12th. As it was still early when we arrived, and being unwilling to waste any time, we determined to push on to the Dihing. The headman Banka had accompanied Mr. Jenkins to the Nonyang lake in 1869, and I asked him for a guide to Honkap, which, together with the neighbouring Nágá villages, are under his rule. He said that the young men were all out in the fields then, and that he could not get them in before night, but he would give us a couple of guides in the morning. This seemed all right, and I gave orders for the camp to go on, telling the interpreter to remain behind till the morning for the guides, who could easily overtake our laden coolies. Shortly afterwards, on asking about the path to Honkap and the guides, Banka seemed to hesitate. I asked if he could give us men who knew the way, and the interpreter answered: "If the Rajah gives the order, a hundred men will go." I replied that we only wanted one man or, at most, two. Banka then said he had no parwanas, "not even from the Darogah, at Sadiya." I showed him those Major Clarke had furnished me with; but they were addressed to all Singpho and Khamti chiefs on the Noa Dihing and Tenga Pani rivers, and he laid stress on the fact that his village, though close to the Noa Dihing, was nevertheless on the Kheram Pani, and consequently the parwanas requiring chiefs to assist me did not apply to him. At last, however, he agreed to give a man, and immediately disappeared into a hut, and we saw him no more. I may mention that this was the only village where I found it necessary to produce my parwanas in order to procure assistance, which was generally most cheerfully given.

Next morning the guide overtook us at a village called Jagun, where he picked up another man, and we went on to the Namchik river and encamped at its junction with the Buri Dihing, the Namrup of the old maps, though why it was called so I am unable to say; the Khamties and Singphos insisting that that is not and never was its name, being known to them as the Namphuk or Jangtuk. My informant told me that Namrup was a name given to it by Mr. Jenkins; but this is evidently wrong, as Wilcox spoke of it as Namrup many years before. Our camp was close to the petroleum springs visited by Captain Hannay in 1845. He says of them: "the hills" (they are such slight undulations as hardly to deserve the name) "here are also intersected by ravines, and in one spot, an extensive basin; a hollow is formed at some height which contains muddy pools in a constant state of activity." The mud is of a pale grey color, through which the petroleum continually bubbles up, heaving up the mud in all directions, while the ground around is like a quicksand. Innumerable traces of elephants, tigers, deer and other animals are seen everywhere in the neighbourhood of these springs. In some places the petroleum is discovered floating in little pools of clear water among the rocks, and it is then of a bright brown color.

At our camping place, we found a party of Nágás engaged in a hunting expedition, and two of them, after a good deal of haggling, agreed to show us a shorter way to Honkap than was known to the Singphos. The elephants had got into trouble in the jungle through which our path had come, and did not get up to us that night. Some rice bags were torn also, which necessitated a stoppage, and the animals did not turn up till noon next day. We were told that elephants could not get any further, and so we lightened all our loads as far as possible, and started with coolies only. We had now to carry the police baggage, ammunition and supplies, as their only carriage was elephants; this brought rather a strain on our Khasia coolies, and we were only able to take away a few days' supplies with us. We camped that night on a small island-patch of grass and shingle in the Khatong stream. The leeches simply swarmed in these jungles, and the space was rather confined on the island, but one of our klassies amused us by saying,—when it was proposed to him by some friends of his to go to the mainland and encamp where there was more room,—"certainly not; on this little island there can only be a certain proportion of leeches to each individual, whereas on the main land there will be an unlimited number to each of us." The next morning, early, we came upon the Namchik again, and followed it up till the afternoon, when we commenced the ascent to Honkap. We arrived at the village about 5. P. M., and encamped near it in some old "jooms." Honkap is a wretched little village of nine or ten houses on a badly cleared site, small shrubs and stumps of trees standing about among the houses.

The next morning, early, we sent back 40 coolies to bring up more "*russód*" from our depôt at Namchik Mukh. With the remainder and a few Nágás we went up to Honkap Hill Station and set about clearing it. We questioned the headmen as to the road to Máum. These hills are quite different to the Nágá hills further west; they are covered with very thick tree jungle. The villages are few, small, and far apart, the paths between them very obscure, and little or no cultivation to be seen except here and there near a village. The villagers evidently had no grain to spare for us, nor could they assist us in the way of carriage. The road to Máum was long and tortuous, and the hills to the east entirely uninhabited. To reach Máum, and clear, we should have to take at least a fortnight's supply with us; and this was utterly impossible with our small body of coolies, and elephants were

out of the question. The only thing we could have done would have been to halt every other day and send back our men to bring up the "*russúd.*" In this way it would have taken us so long to reach Máum, that probably we should have exhausted our supplies before we had done any useful clearing. It was very reluctantly that we came to this conclusion, but it forced itself upon us, and we saw that, late in the season as it then was, the best, indeed only thing to be done in this jungle-ridden country in which no plane-tabling could be done, was to retrace our steps to the lower ground and determine by actual measurement the course of the Noa Dihing and other small streams hitherto unexplored, and fix the positions of the villages which we knew lay scattered about in the plains, but of which no sign was visible in the apparently unbroken mass of forest at our feet. As the Namchik and Namphuk flow on either side of Honkap ridge, and neither had been surveyed at all accurately, we separated on the 19th February, Mr. Ogle undertaking to survey the Namchik, and I the Namrup. I reached that river in the evening, and next morning commenced work from Namphuk village.

The survey of the river was difficult, as in many places it was too deep for wading, and the banks were impracticable at those parts, and we had to resort to rafts in some parts where long deep pools lay between precipitous rocky banks, along which, before we constructed rafts, it took us three hours to make a quarter of a mile of way. On the 26th, Mr. Ogle rejoined me at Jugun, and together we carried on the survey of the Dihing as far as Bisa, where we connected it with the Revenue pillar, or rather what was pointed out to us as its site, the pillar itself having long since disappeared under combined attacks of the village domestic animals and children. We reached Bisa early in the afternoon of the 27th, and remained encamped there till the next morning, when we went into Wakidgáon. Banka did not show himself while we were at his village, and I understood he was absent at a merry-making in the neighbourhood. I was therefore surprised to learn from the interpreter on starting that he had been in the village all the time, but had declined to go and see me unless I sent for him. Having no particular wish to see him, I told the "dobashi" to let him know that I should report his conduct to Colonel Graham, as it presented such marked contrast to the usual reception accorded to us by the Singpho and Khamti Chiefs generally.

We remained at Wakidgaon till the 7th, despatching correspondence, pay bills, &c., and making arrangements for sending a month's supplies round to Chaosamgaon on the Tenga Pani, to which place we intended to work our way round by different routes. Mr. Ogle, starting from Munglang, near which a Revenue Survey pillar gave him an initial point, was to follow up the Jengthu river, and crossing the Manabum range near its sources, proceed to Latoh,* while I tracked the Noa Dihing up from its junction with the Buri Dihing as far as possible, and then crossed to Latoh. We separated again on the 7th March, arriving at the point where the Noa Dihing bifurcates. I commenced on the 9th to survey down the river. The day was fine, and we had no difficulty in wading across the river where necessary, and by evening I had done about 4 miles. Next day was wet, and the rain hindered my work, so that we did not accomplish 3 miles. The river was rising slightly; and as I was dressing on the 11th I heard a commotion; running out of my tent I saw it was caused by a deer which attempted to cross the river above our camp, but had been carried away by the rising stream. The elephants were coming across from the opposite bank, and headed the deer towards a shallow part, and a crowd of coolies and klassies rushing in, seized and brought him on shore in triumph, when he was speedily killed and transferred to the larder. This day again was wet. We reached the Buri Dihing Mukh in the evening, and fortunately found a high bank for our camp, for heavy thunder-storms raged, and the river rose 3 feet during the night. The rain continuing with only short intervals of fine weather, we were detained at the camp for two days, as I found it impossible to get more than 1 mile done each day, the swollen state of the river necessitating my crossing and re-crossing my chainmen and flagmen at every few yards, a work of time, as I had only two boats with me, the remainder having been sent with the stores to Chaosamgaon. Several small streams fall into the Dihing near here, and these I explored for a certain distance up each. They are narrow and shallow in parts, but frequently we came across long deep pools, through which it is impossible to wade, and the jungly banks being almost impassable, our progress was rather slow. Had I followed up all these streams to their sources, no time would have been left for anything else, and being small, and of very little importance, I did not consider they were worth wasting a season on. Should an extension of the survey be made in these parts, and it is considered necessary to have a more accurate record of these streams, the survey of them should be entrusted to Native Surveyors, who would do them at a comparatively small cost in the driest part of the season before the early rains set in. I then returned up to the Noa Dihing to continue the survey of that river.

* Latora of the old maps.

Such was the result of the heavy storms which now raged almost daily, that it was difficult to recognise the river we had gone down so lately; what had then been perfectly dry channels, were now foaming torrents, and the places where we had waded little more than ankle-deep in water, could now only be crossed in boats. The Noa Dihing divides up into several big channels above the point of bifurcation, and the weather being against us, I did not reach the Pakan Pani till the 29th March, having made one digression to Namphai, a village about 5 miles south-west of Bishigaon. I was detained at this village for some little time, as the river again rose so suddenly one night that I could not cross my camp to go to Namphai; and as this was the last village in that direction, I was anxious not to leave it undetermined. The current here was so strong that the boats were swept down a quarter mile on casting loose, and the boatmen refused to run the risk of crossing coolies and baggage. From several observations I found that the stream was

running at the rate of 9 miles an hour, and this not at the rapids. The stream is full of "snags," and is exceedingly dangerous when full. Three houses were blown down in Bishigaon during a storm one night while we were there. Our camp was fortunately in rather a sheltered nook at the foot of a low hill, otherwise our tents and leaf huts would have stood a poor chance. Mr. Ogle's route brought him to within a few miles of Bishigaon while I was there, and we saw each other for a few minutes on the 25th March, parting again till the 4th April, when I rejoined him at Latoh. I was delayed longer than I had expected by having to halt on the Pakan Pani and send all the coolies to cut an onward path for several miles after leaving this stream, the old path having got quite choked with the tangled cane jungle which there grows most luxuriantly. From Latoh we worked down together (taking different portions of the stream) to Palumpangaon, a large Khamti village, where we arrived on the 6th. We halted on the 7th to do some work in the neighbourhood, and finding we were only two days' easy journey from the Brahmakund, we determined to pay this famous spot a visit, and see what facilities the country offered for an extension of the survey in that direction. We arrived there early on the 10th, a heavy storm having delayed us the day before.

This place has been so often described, that I should only be repeating by saying anything about it here, beyond the fact that we were much disappointed in it, and so indeed were most of the Hindus with us, with whom it had been the height of ambition to see the "Pansaram Kund" as they called it. Many utterly refused to believe for a long time that this dirty little pool among the rocks with a few red rags on long sticks rising out of it was really the sacred pool which had existed in their imagination as a most gorgeous place, marble bathing ghâts and fine temples towering above a large lake. On the 12th we again reached Palumpangaon, and on the 13th left again for Chaosamgaon, or Chankam as it is variously called, Mr. Ogle surveying the land route while I explored the river.

We halted at Chankam for three days for correspondence, &c., and had a visit from Lieutenant Harman, R. E., who had been to look at Manâbum to ascertain its suitability for a Great Trigonometrical station, and hearing at Lathao that we were only a few hours' journey higher up, came on to talk over matters. On the 18th Mr. Ogle and I left Chaosamgaon to explore the Mora Tenga river, the Khaiki and other small streams flowing from Manâbum into the Tenga Pani. We connected our work with the Hill Station on Manâbum, and took our final observations from that place on the 27th. I had arranged with Lieutenant Harman to take the third angle from there of the triangle Sadiya, Saikwa, Manâbum, and had sent heliotropers to the two former stations. Lieutenant Harman also said he would leave a heliotroper at Manâbum till he had observed to that place from Sadiya and Saikwa. When we arrived at Manâbum, we found that this man had left (under a misapprehension as we afterwards learnt), and concluded that the other two angles were secured. We could not get the heliotrope at Saikwa to show out at all for two days. On the third, when we were despairing of seeing it, and thought that at any rate the other two angles would be sufficient to check our position as fixed from the Sadiya base, we caught sight of a slight flicker among the trees. By dint of intent watching, we at last got the angle, and on the 28th April arrived in Sadiya. Mr. Ogle visited the Saikwa station to ascertain the cause of the heliotrope having shown so feebly from that place, and found that the line was not open to Manâbum, and we had only seen the heliotrope from its being put on a lofty platform. The jungle was much heavier than Lieutenant Harman had anticipated, and the line was not fairly opened up last season. However, the angles we got will be quite sufficient to fix all our points satisfactorily.

On the 30th April we left Sadiya for Dibrugarh. We stayed for a day at one of his points near Pubha with Lieutenant Harman, whom we found exceedingly weak and ill from a sudden and severe attack of fever. One of his assistants, Mr. McCarthy, joined him in the evening, and as he was much better the next morning, we went on our way to Dibrugarh, arriving there on the 3rd. We left again on the 8th, and reached Shillong, Mr. Ogle on the 15th, and I on the 24th May.

The results of the season's work are as follows:—717 square miles of country have been mapped, and a large number of points fixed by triangulation, enclosing an area of 2,000 square miles. The positions of 37 villages not previously fixed have been determined, and 250 miles route survey and traverses been run. With the exception of the last mentioned piece of work, of which Mr. Ogle did about 140 and I about 110 miles, it is impossible, from the nature of the survey, to separate the work performed by each of us.

General description of the country, &c.

A glance at the map forwarded with my letter dated April 17th, from Chaosamgaon (*i. e.*, a trace of our work), will show that the Noa Dihing is the principal river in the country surveyed by us. This stream throughout the portion mapped by us is a succession of strong rapids and deep pools, and full of "snags,"—tall trees which have been rooted up and carried down in floods. These are so numerous as to make the river when at all swollen exceedingly dangerous to navigate. One day I passed up a certain portion, and noticed an immense bare tree whose trunk was fully 80 feet long lying in mid-stream. A few days afterwards, passing down again, a rise of a foot or so in the river had enabled it to carry this tree a couple of hundred yards lower down. Our boatmen used to excite our admiration by the skill with which they managed their frail "dug-outs" as we were carried down the stream; now dancing along over regular waves down a boisterous rapid, whose rush is so great as to form a trough in the centre down which we are swept, the water at the banks being above the level of our boats; now hurrying along a smoother, but still violent course; here and there huge columns of foaming water showing how angrily the stream resents the obstruction offered to its progress by the large roots of a fallen tree, round which a whirlpool rages, and into which it seems our boat

must inevitably be drawn, when, lo! a dexterous turn of the wrist by our steersman, and we have glided safely past the threatened destruction. It can readily be supposed that these "snags" accumulating in floods and blocking up the river divert it into other channels, especially where it emerges from the hills into the liberty of the plains, and finds nothing to prevent its choosing its own course. One new channel of several miles in length, the Noa Dihing has lately made for itself west of Bishigaon, the old and new channels forming a loop ¾ mile broad, the upper one, *i. e.*, the new one, running for a greater portion of its length through forest land at a higher elevation than the corresponding portion of the old channel, and indications are not wanting to show that it will probably soon take its course even south of the new channel again, and go wandering away altogether from its present bed, when its communication with the branch running past Wakidgaon may be cut off altogether. In Wilcox's time the whole volume of the Noa Dihing found its way to the Brahmaputra through this channel in the cold season: he says "the opening now called the New Dihing was very gradually enlarged by the influence of successive rains causing an equivalent diminution to the ancient Dehing, the old communication with which has no water in the cold season, and, indeed, the name of Buri Dihing might fairly be dropped in favor of the Namrup from which it derives its present supply."

Now, however, the case is the reverse. In 1841 Captain Vetch, Political Agent, Upper Assam, wrote:—"Visited point where the Buri and Noa Dihings break into separate rivers. I found the mouth of the latter just filling up with stones and drift-wood, and the Singphos seem to think this channel will close in a few years, and this will send the whole of the waters down the Buri Dihing." This has not happened yet, though 36 years have passed. My "dobashi" told me, though, that the Noa Dihing is gradually getting smaller, and its mouth will probably close ere long with the apparent tendency of the main stream to a more southerly course. When part of the Buri Dihing was surveyed by the Revenue Survey in 1872, a large portion of this river found its way into the Kheram Pani apparently; now the communication is closed, except occasionally in very high floods during the rains. The Kheram Pani now rises. I was told, from a small swamp, and nowhere is it more than a few inches deep.

On the Noa Dihing west of Pakan Pani Mukh, are the sites of several now deserted villages which were flourishing in Wilcox's time, such as Nelong, Kasan, Gakhen, &c. In Kasan, near the Pen Pani Mukh, is an old tree on which I cut a broad arrow with 1877 underneath. This would make a good starting point for any fresh traverse up the Noa Dihing, which is called the Diun river by the Singphos, Dihing being an Assamese corruption of this name, according to my informant, a son of Bida, a very intelligent young fellow, whom I met by chance near the Dihing one day.

The Pakan Pani is the largest stream I saw flowing into the Dihing from the high hills. My route lay up its bed for about 7 miles. The violence of its stream in flood is evidenced by its wonderfully straight course from a high hill called Katoh, the width and bareness of its bouldery bed and its steady slope at first 2° gradually increasing to 3° and 4°. It is subject to very sudden and violent floods, and I was told of a party of 12 Singphos encamping at its mouth, one night being overtaken by one of these sudden rises, and all except one were swept away and drowned.

The rivers flowing into the smaller branch of the Noa Dihing are the Jengthu* rising on the west face of the Manábum range, and the Tenga Pani on the east. This latter receives several streams from the same range, such as the Tenga Pani, Khaika, Kumlao, &c. The Tenga Pani is a very pretty stream, winding through tall forest; in some parts open forest, in others the rank undergrowth comes quite down into the water, spreading its lower foliage far out over the stream, and giving the impression that the vegetation is resting on the water and not growing from the banks. Here the tall, creeper-festooned trees, spring up from the low earth-bank; there a close fringe of cane or the broad leaves of tall grasses and large ferns clothe the banks, the trees rising up behind it, and in many places occur very pretty little islands, low patches of ground, only a few feet out of the water at their highest part. The upper ends of these islands are almost invariably bare of jungle, but covered with a short, soft, close grass passing into ferns and small shrubs, ending in big bushes and trees which clothe the rest of the islands. These must be mostly submerged during the rains; and the seething mass of waters at the upper ends of the islands, where the stream divides, tends to keep down the vegetation at these places. The Tenga Pani resembles this somewhat on a smaller scale near Chaosamgaon and below it, but the other streams, flowing through uninhabitable jungle, are blocked in many places with fallen trees or bamboos interlacing overhead; sometimes flowing in shallow rapids, again forming deep stagnant pools with soft muddy beds enclosed on either side with the coarse matted grass and tangled cane growing out of the mud and slime that compose the banks. It will be admitted, I think, that these were difficult to survey. We did as much as time admitted with regard to a due connection of our work and a fairly accurate knowledge of the country enclosed in our traverse. A few miles of some of these smaller streams have been unexplored; but their sources and general directions are known. Few human beings ever visit them, except when an occasional party of Singphos go up to cut Toko Pat leaves, which here attain magnificent dimensions; but as it was, we penetrated several miles beyond the point where such a party whom we met told us it would be impossible for us to go; they themselves having been obliged to turn back. Flowing, as these streams do, through low swampy ground, the fall of a tree is sufficient to divert them into new channels, many of which were pointed out to us as having been formed during the past year, while in many places we could foresee other speedy changes of course. Therefore, accurate measurement of these streams would be work thrown away;

* Described by Mr. Ogle. See Appendix A.

the most exact map of this year would be utterly wrong the next. A curious feature in some of these streams is that on first leaving the hills they flow with a good body of water swiftly; following them down they gradually get smaller and at last disappear entirely in their sandy or pebbly beds. In the Tenga Pani above Tabum the river suddenly disappears for over a mile, and then as suddenly re-appears, flowing as briskly as ever.

In carrying on our surveys in these rivers we found canes very useful for making measurements instead of the ordinary heavy chain. The canes were light and floated on the water, being easily pulled out straight. I tried them across strong rapids, and found the results wonderfully good when tested by triangulation. We were indebted to Mr. A. W. Chennell for this idea. It had struck him when working in very similar country in the Dhansiri valley, in 1873-74, and he had proved the advantages of working with light canes. Chains could not have been used in rapids, or indeed in any water, with the slightest approach to accuracy; ropes are very unreliable, and neither could have stood the wear and tear of the rough boulders of the Noa Dihing and Pakan Pani. The canes of course were frequently tested with accurately measured 10-foot rods (dry male bamboos).

An idea of the general character of the country surveyed will have been gleaned from the foregoing paragraphs. The Manábum hills were the only break in the general dead level of the country, and their height was only about 500 or 600 feet above the surrounding plains. They are formed of soft sandstone, and are precipitous to the west, but slope away very gradually on the east to the Tenga Pani. The climate was pleasant in January and part of February, but from early in March we had an immense amount of rain accompanied by fearful storms of wind and hail. I note from my diary that out of the 53 days between the 6th March and 28th April we had only 23 days of fine weather, the remaining 30 being wet. The maximum and minimum thermometer gave readings as in the margin. The maximum reading of course could only be taken during a halt; the minimum thermometer was read almost every morning.

Date.			Place.	Thermometer.		Remarks.
Month.	From.	To.		Maximum.	Minimum.	
January ..	1	12	Sadiya	76°	38°	
,,	12	17	Tenga Pani	,,	44°	
,,	17	27	Manábum Hill	67°	56°	Camp on Hill 320 feet, but forest trees surrounding it kept it warm.
February..	1	6	Sadiya	70°	51°	Rainy.
,,	7	10	Noa Dihing ...	,,	53°	Do.
,,	10	15	Bisa and Namchik ...	,,	45°	
,,	15	18	Homkáp ...	76°	48°	9,000 feet.
,,	18	28	Namphuk and Buri Dihing	80°	50°	Average 500 feet.
March ..	1	31	Dihing	85°	56°	,, 600 feet.
April ..	1	8	Tenga Pani	,,	56°	Thermometer broken in high wind on the 9th.

The Singphos and Khamtis have been repeatedly described, so that it would be merely a vain repetition to do so here. I may however mention a few ceremonies which we witnessed, and make a few remarks on the Nágás we came across.

At Wakidgaon in the early part of March we witnessed a religious ceremony, which was also performed generally among the Singphos at the same season. The day previous, at certain spots near the headman's house, large posts were put up in the shapes of St. Andrew's Cross, intersected by an upright cross, having as finials, small funnel-shaped baskets containing leaves. In front of these again were tufts of tall grass planted in a rectangle of about 8 feet by 4 feet. Early on the morning of the ceremony, little platters on curved legs containing offerings of cloths, flowers, fruits, &c., were brought out and arranged alongside the tufts. Then a couple of buffaloes were brought and secured strongly to posts hard by, and finally about 10 o'clock, the celebrants took their places on low stools in front of the grass, and with long green wands in their hands, which they moved about from time to time to attract the attention of their deities, they commenced a chant, with the same intonation as used by Catholic priests in reciting long prayers. This chant, the burden of which is an invocation to their gods to visit them, bless them, their families and villages, and keep all sickness or evil from them, they kept up without ceasing till past noon, when a pig was brought out and its head severed with one blow; then a long string of bamboo was taken from the nearest buffalo to the headman's house and into the innermost recess; this was to intimate to the household god that the sacrifice of the buffalo was about to take place and to show him the way out to it. After a few more incantations the officiant threw some powdered ashes out of a leafy funnel on to the animal's neck; the beast was then hobbled and thrown, and its neck being cut slightly as a guide, a man with a sharp "dáo" severed the head with two strokes. The women then filled some bamboos with blood, and walked in procession to the other cross, where a few prayers were said, the bamboos deposited, and they returned. The second buffalo was then speared to death, its agonies being prolonged by the endeavour to send the spear always into the same spot exactly, which could only be done when the poor beast came to a stand-still after each effort to break loose. The animals were then cut up, and the flesh thrown into huge cauldrons over blazing fires and cooked, as also an immense quantity of rice. When ready to be eaten, large mats were spread near, and fresh plantain leaves laid over them, in which the contents of the cauldrons were deposited, and the meat cut up into convenient-sized pieces; these, with a proper proportion of rice, were then made up into little parcels in green leaves and put into baskets, which were then carried round the village for distribution, all our people coming in for their share, or at least such as would take it. The Singphos were evidently rather hurt by the somewhat contemptuous refusal of our Hindus to accept the proffered food, another instance of the difficulties which caste prejudices among his followers throw in the way of a surveyor among

these wild tribes. The headman presented us with a couple of bottles of Singpho liquor (exceedingly like Scotch whiskey in taste and appearance) and some of the young buffalo steaks, and exceedingly good they turned out to be, though we had had our doubts about them at first. This distribution of food took place about 5 P. M., and after that, contrary to our expectations, although a good deal of liquor was drunk, not the slightest disturbance took place; the women came as usual at dusk to sit round our fire and listen to the musical box (for which the ladies always asked at every village we went to) and imbibe small doses of "anisette," a liqueur I had bought especially for such purposes, and which they relished very much. When we went to dinner they left, and after that everything was perfectly quiet.

The other festival we saw was the Khamti celebration of the Behu, which took place at Palumpan and Chaosamgaon while we were at these villages. Over a small well dug in the ground boarding was placed, and on this all their marble and gilt idols were ranged, interspersed with brass vases filled with sprays of leaves. In the centre rose a big bamboo about four feet high, pivotted above and below; from this several small bamboo tubes projected upwards from various points, being connected together at their ends and to the centre bamboo by colored threads. These small tubes were pierced with holes in several places throughout their length. The well with the idols, &c., were all enclosed and covered in by a pretty ornamental lattice-work of fine bamboo, above which stood beautiful miniature temples made out of the brown pith of some grasses, and at the corners of the enclosure rose coloured umbrellas on tall poles and on streamers of red and white cloth, thoroughly Burmese in appearance. Water at times was poured, while reciting prayers, into a trough full of leaves, whence it flowed into the centre bamboo above mentioned, and finding its way out through the holes in the small arms, caused the whole to revolve, on the principle of the turbine, rapidly watering all the gods impartially as they sat calmly beneath. People came at intervals throughout the day to fill the trough. The young women went about with "chungas" full of water, emptying them over all who came in their way, irrespective of age, sex or condition, and groups of both sexes were to be seen in the river all day long, engaged in furious splashing matches. The boys made big bamboo squirts, which they used most effectively whenever opportunity offered. All was done with the most perfect good humour, and not a soul lost his or her temper. At night the youths had an entertainment, in which character-dances found a prominent feature.

The Nágás of Honkap and the neighbourhood all seem to be subject to a certain extent to the Singphos. In almost every village of the latter along the Dihing we saw several Nágás who live with the Singphos for a certain period every year, receiving free quarters and food, for which, in return they go into the jungles and cut rubber for their masters, by whom they are allowed to keep one-third of what they collect. They also help the Singphos in various ways, such as cultivation, &c. The Singphos have several fields of opium along the Dihing, but in the Tenga Pani villages we did not see any; there is a field near Chaomang. This village is on the Tenga Pani, I believe, but we did not come across it, and I dare say there are others off the line of survey which we did not see. These Honkap and other Nágás do not differ much in their appearance, dress, style of building, &c, from those we have met further west, except that their villages are small, and they themselves a dirty, poverty-stricken looking race, with little of the fine physique or air of independence seen among their western neighbours.

In the event of exploring the Patkoi range and Nonyang lake, Namphuk would make a good depôt. Bishigaon would be the best depôt for a party clearing Miaobum (called originally "Dapha Bum," a mistake of some men who first gave us names of hill peaks from Sadiya). The path to Nonyang lies between Maum and Miaobum. There is a path to the latter hill from Bishigaon.

Extract from letter dated Shillong, the 13th July 1877, from MR. M. J. OGLE, *Surveyor, No. 6 Topographical Survey, to* LIEUT. R. G. WOODTHORPE, R.E., *Assistant Superintendent, Topographical Survey.*

Your instructions were to start work from the Revenue Survey Pillar near Munglang, carry a traverse up the Jengthu river, and then taking it on by village-paths to join you somewhere on the Noa Dehing, when we should decide as to the most feasible route across the Manabum range.

After making out our reports, disposing of general correspondence, and the arrangements for the removal of stores to Chaosam had been completed, we left Wakidgaon on the same day (7th March) with a month's supplies, suitable establishments, &c.

My first march was down the Noa Dehing to the village of Modai. I traversed up the river bearing the same name, a clear shallow stream running over a rocky bed; the next day I also traversed up it as far as where it was joined by another small stream. Here we met a party of Singphos who were busy in clearing a site for a new village; it was fortunate that we met them as they showed my coolies a direct path to Modai, thus avoiding the necessity of wading back some four miles through water.

On the next day we left Modai and accomplished a very hot and fatiguing march. The way led along the sandy bed of the Noa Dehing which was frequently crossed, the water in it being very shallow there. On arriving at Munglang I sent for Ningro Saman, the Raja, and asked him for guides to point out where the Revenue Survey Pillar was; he sent two boys who showed me the place, otherwise it would have been difficult to find it, as it was in dense forest about 50 yards from the bank of the river. The pillar was in a very bad state, no mortar having been used; the bricks were kept in their places by stakes being driven round: these had rotted and more than half the pillar had tumbled down.

On the 10th I started work from this pillar and carried it along the bed of the Noa Dehing as far as the Khamti village of Rangagura, when I left it and followed the path to Nallamgaon, which led through forest for about a mile and then struck the Jengthu river; two miles further up was Nallamgaon where we encamped for the night. The next day the work progressed as far as Inthem, to which we shifted camp. The Rajah of this place was particularly civil, and after some conversation asked permission to allow the women to come and see me,—a request I very readily granted. His wife presented me with a fowl, eggs and rice, and I was sorry that I could not return the compliment in a manner that would have been more befitting and pleasing to the female mind than the bestowal of a bottle of rum and a few four-anna and two-anna pieces. After the women left, I started off for work, the Rajah accompanying me. He very soon got disgusted and expressed surprise at my undergoing such great inconvenience; he however did not desert, but returned to camp with me late at night. On the 13th I left the village, presenting the Rajah with powder and shot and a bottle of rum for all his civility.

It was now no easy matter traversing along the bed of the river, as rain had set in from the 10th, causing the river to rise considerably; we were frequently up to our waists in water, the chainmen being often up to their necks, and the rapidity with which the water was flowing rendered it difficult to make way against the current; progress was consequently very slow.

On the 15th we passed the village of Sanglai and encamped about a mile above it. There was very heavy rain on the 14th and the two following nights, and the river rose to such an extent that we were obliged to leave it and cut lines along the bank. The undergrowth and cane-jungle was so dense that not more than a mile a day could be accomplished. On the 18th it was cloudy but no rain fell, and the water in the river subsided a good deal, but it was still much swollen and rapid, not so much however as to prevent our wading through it. On the 19th clear weather set in, but a new obstacle rendering rapid progress impossible presented itself. I should mention that the channel is kept clear of snags and fallen bamboos up to Sanglai and a little beyond for the passage of boats; three years ago it was kept clear as far as Nao, but now the river was choked up with these impediments, and they had either to be cut through or we had to take to the bank till they were passed.

On the 21st Thingba was reached. At this place the survey along the bed of the river was abandoned, the village-paths being chained as the river kept close along them and was frequently crossed, a fortunate thing, as heavy rain accompanied with hailstorms commenced and caused the river to rise again very suddenly. The next day a route survey was carried into Nao on the Modai river, about 2½ miles to the west of Thingba and consequently off the direct line of march.

While engaged in carrying on the survey into Nao, I deputed four coolies with a klassie to clear the line into Manau, about ¾ of a mile from Thingba on the direct road to the Noa Dehing. On my return to camp I was surprised to see these men. They said that the people had turned them back, and had told them in the best Assamese they could muster up and by gestures that they would not allow the survey to pass their village. Through my Dobasha I found this to be true, but on my arrival at the village the people denied having sent my men back, saying that it was owing to the mutual ignorance of being able to explain matters to one another that the misunderstanding occurred. However this might be, the inhabitants did not show that attention and civility which we experienced in almost every other Singpho village through which we went. I passed the hut where the Rajah was; he made no attempt to recognize me, but kept on in his gambling game. We proceeded to Inring and pitched camp there.

Near this village there is an extensive clearing, and it was the first place since leaving Wakidgaon that I got a view of the hills at all. By taking bearings to a few peaks on the Mavalum range, I managed to fix them and determined the source of the Jengthu (which is called the Modai here) with its principal tributaries. The Inring Rajah accompanied me to the clearing and gave me some valuable information regarding the sources and names of these rivers and peaks.

The next march was to the deserted village of Ndong situated on the right bank of the Noa Dehing. We arrived at this place on the 23rd, and the next morning after taking theodolite observations to Honkap and several other peaks for the adjustment of my traverse which had now progressed about 45 miles without a check of any kind, I carried the route survey into Khagam, and the next morning I met you at Phupgaon.

Enquiries from the Singphos elicited the information that elephants could be taken across the Manabum range by following the path up the Melep river; you therefore deputed me to take that route and survey across the hills and down the Tenga Pani as far as Latoh where you would join me. I left Khagam the same day that we parted and proceeded up the bed of the Melep river and succeeded in doing 2 miles of route in the afternoon, the weather luckily being fine. We followed the course of this stream next day also and encamped at the foot of the hill, just near its ascent. On the following morning I sent men up the ridge in advance to report on the road; they returned with the disheartening intelligence of the impracticability of it for elephants: the sides of the hill near the top they said were a great deal too steep for the animals to get a footing. I did not heed them however, but went up to judge for myself. I certainly did find the sides precipitous but not quite so bad as to prevent unladen elephants making the ascent. I therefore sent down word to get the coolies to bring up all the baggage and rice; this they did in three or four trips, carrying heavy loads each time; the

elephants followed and arrived safely. The descent on the opposite side was on the back of a spur having a very easy gentle slope. I carried the survey about 1¼ miles along it and pitched camp on a level bit of ground, water being fortunately found about ½ a mile below.

On the 28th I went back to the summit and cleared enough to get in some topography; this was the first day I had an opportunity of setting up my plane-table since leaving Wakidgnon and I was able to do so frequently afterwards. After we crossed the range and entered the low flat country again, the bamboo jungle was so thick that I saw it was impossible for laden elephants to get through, and I was anxious about them as we had lost all traces of them; having no guide I was in dread of their going astray and wandering about those terrible forests. We, however, came upon them in the bed of a large dry stream along which the path now lay to its junction with the Tenga Pani, they had gone down a small ravine which joined the former. I found my camp pitched in a dry spot on the Tenga Pani near the small village of Tabom.

On the 29th, I was obliged to retrace my steps to the point where the path joined the dry stream. Such heavy rain had fallen during the night that a considerable body of water was now flowing down it. On my return to camp I found a Mishmi Chief and two headmen from Tabom waiting for me with presents.

The next day I traversed down the river to near Ndong and on the following day carried a rough route by pacing into Insha about 6½ miles to the north-east of Ndong and situated near the foot of the Kamfai range of hills. On the morning of the 1st April the widow of the former Rajah (she still had some authority in the village) accompanied by others, men and women, came out to our camp to see me, and after some conversation I retraced my steps to Ndong and carried on the route survey to within 2 miles of Latoh, I might mention here before proceeding that Ndong is beautifully situated on the high right bank of the Tenga Pani and a good view of the Manabum range is obtained. The next day the survey was completed to Latoh and another route was carried by pacing to Tangsang about a mile from the former village; the Chief of which accompanied me there having donned his best attire for the visit. The headman of Tangsang came out to meet me and invited me to his house,—an offer I gladly accepted as a heavy storm was brewing which came down in torrents shortly after.

I should not fail to let you know of the civility with which I was received by the Chief of Latoh. On my arrival late in the evening he came down to camp and was most assiduous in his attentions towards me. During our stay of four days in his village, he either sent through his son or brought down himself something for me; his wife also presented me with fowls, &c. and I was glad of your presence there to have it in my power to reward her more suitably than I could the Inthem Chief's wife.

On the 3rd I surveyed down the Teng Pani for 4 miles, accompanied by two men from Latoh, whom the Rajah deputed with me to point out villages that were inland and also to show me the path back. On the following day I traversed up the Lapang pani, a narrow rapid stream, for some 3 miles, and on coming out again upon the Teng Pani I met you and we returned to camp together. From the 5th we worked in conjunction till our labors were closed at the trigonometrically fixed station on Manabum; it is therefore unnecessary for me to continue this narrative, and I shall therefore conclude with a few remarks on the country traversed by me.

The only rivers of importance in the tract I was engaged upon are the Jengthu, Teng Pani and Tenga Pani; but as the two latter I presume, have been described by you I shall confine myself to the former. From the village of Inthem the Jengthu river has water in it from bank to bank, and has an average width of about 30 yards, almost up to the village of Inring. Below Inthem there are short sandy reaches and the river has a comparatively straight course, but about that place it is most tortuous, and winding and rapids occur. Near the village of Thingba the river bifurcates and from that point, the eastern and main branch is called the Jengthu and the other which joins the Noa Dehing near the village of Modai is called the Modai Pani. Throughout their whole course they flow through dark rank jungle unrelieved by anything picturesque, and we were seldom even favored with a glimpse of the sky above. It was most dispiriting.

The clearings about the villages are very insignificant. From no place in the Jengthu valley but Inring could a view of the hills be obtained at all, owing to the immense walls of forest all round. Poppy cultivation was seen in places, but the largest I saw in the whole of the Singpho country was on the road to deserted Ndong, from Inring. The paths from Munglang to the villages on the Jengthu are very narrow and do not seem to be much used, but those from Nao to Thingba, and from there on to the villages on the Noa Dehing, are wide and kept in good order, rendering elephant travelling very easy.

Extract from the Narrative Report of LIEUTENANT E. P. LEACH, R. E., *Offg. in charge No. 7 Topographical Party, Rajputana Survey.*

Description of ground triangulated.

The triangulation extended over an extremely desolate and sandy tract lying between Bickaneer and Sirsa in British territory ($\frac{28°\ 0'}{29°\ 0'}$, $\frac{73°\ 30'}{75°\ 0'}$).

Both surveyors reported great scarcity of water for drinking purposes, and few villages.

Approaching the borders of Hissar and Sirsa, the ground falls rapidly, and the sand ridges covering the southern and western portions of the area brought under triangulation dis-

appear. The sub-soil is a mixture of clay and gravel, and the surface of the country uniformly level.

An imaginary line drawn between Hissar on the east and Nagore in Marwar on the west, prolonged southwards to the Luni river, would form an approximate boundary to the Bickaneer desert proper. This tract is covered by low sand ridges, and is almost entirely devoid of surface vegetation or water, except immediately after the rainy season.

A substratum of clay underlies the sand at a depth varying from a few feet to several hundred; and in all cases the wells have to be carried down to the clay level. The direction of the sand ridges, as might be expected, is at right angles to the prevailing north-east and south-west winds, and in places the clay bed becomes completely exposed. Where this is the case, small excavations, called "*tobas*," are made, and the rainfall is collected. These "*tobas*," or tanks, last a few months, but dry up at the end of January, and the inhabitants are then entirely dependent upon their wells, which are more or less brackish according to the depth of sand through which they have been driven. A small supply of drinking water can usually be obtained from large villages, where the rainfall is stored in underground masonry reservoirs or "*tonkas*." These are scrupulously concealed, and their existence often entirely ignored till a little pressure has been brought to bear upon the proprietor.

In the cold weather the brackishness of the well water seems to have little effect upon natives. The party has enjoyed extremely good health, and the monotony of the country is its principal drawback.

In an ordinary season, the only difficulties a surveyor has to contend against are the distance from which his water has to be carried, and the scarcity of grass for his horses and forage for his camels.

The former thrive well upon husked "*moth*," or vetches; the latter, upon the leaves of a small thorny bush, a kind of wild plum, which at a certain season are carefully stored and sell at almost as high a price as the grain of the district.

The effect of a dry season is therefore to create an almost entire absence of the stunted grass with which the sand is partly covered, and to raise the price of the stored fodder or "*pálá*" immensely.

Country plane-tabled.

A few isolated groups of hills appear upon the Standard Sheets of the year, the last to be met with northwards to the banks of the Sutlej.

The country plane-tabled was similar in all respects to that described in my Narrative Report last year, well populated, and almost entirely cultivated for light crops during the rainy season. The soil sandy, with no drainage lines, and little or no surface water. The inhabitants are well-to-do, and a considerable trade exists between the Hissar and Delhi Districts and the large towns of Sujangarh in Bickaneer, and Didwáná, Nagore, and Mirta, in Marwar.

The large town of Kuchawan in the south-east corner of Degree Sheet XI, upon the borders of the Sámbhar Lake, has an extremely picturesque fort in a good state of preservation, towering some 500 feet above the city below, and covering the summit of an isolated mass of sandstone rock.

In its neighbourhood are the marble quarries of Makrána, from which large quantities of stone are exported into the Jeypore and Ajmere Districts. Further west lies the old town of Katoh, at the foot of a low group of hills, largely quarried for building purposes; and in the centre of the same sheet the large town of Didwáná, where an inferior kind of salt is manufactured from a salt lake of similar formation to those at Sámbhar and Kuchawan.

City of Nagore.

Nagore, a city of considerable historical celebrity in the annals of Marwar, falls within the area surveyed, but will not appear in the sheets published this year. It is the head-quarters of one of the largest pergunnahs in Marwar, and is enclosed by a bastioned wall in good repair. The following description is abstracted from Mr. Kelly's report: "Nagore is situate about 80 miles north-west of Ajmere, and the same distance north-east of Joodhpoor, the capital of Marwar. Bickaneer lies to the north at a distance of 68 miles, and Sujangarh to the north-east, 64 miles distant. It is built upon slightly rising ground, in the hollow of the surrounding country, so that its fine tanks, six in number, are always full. A high stone wall, three miles in circumference, encloses the city, strengthened at every 60 yards by bastions, surmounted with old, rusty, field-pieces.

"The wall, like the ramparts of the fort, which is in the heart of the city, is in good condition and of considerable antiquity.

"Five hundred and fifty-five villages are included in the pergunnah of Nagore. Of these, 391 are '*khalsa*' or crown, 191 '*jaghir*' or fiefs, the remainder '*udik*' or gifts to the Brahmins.

"The population is about 21,000; Mahomedans being in the proportion of 2 to 5. Before the famine year 1868-69 its inhabitants numbered more than 26,000.

"Nagore mints its own copper coin, and has a cutcherry subordinate to Joodhpoor.

"A local post runs between Joodhpoor, Bickáneer, Sujangarh, and Didwáná, and there is a Government branch office connected with Ajmere and Mirta.

"Its imports consist of salt from Phalodi and Didwáná, sugar from Beani, and wheat and other grains from the neighbouring villages. Its exports are wools, cloths, saltpetre, and large number of iron and brass vessels. The revenue of Nagore is Rs. 7,000; of the pergunnah Rs. 29,000."

Water is good and plentiful, and the district is celebrated for its breed of cattle: the soil is extremely fertile, and the assessment in consequence higher than in other parts of Marwar.

As an instance of the utility of the heliotrope as a signalling instrument in dry districts, it may be mentioned that a flash telegraph, worked with ordinary looking glasses, is in constant communication with Ajmere, and is carried northwards as far as Bickaneer.

The stations usually on the sites of old survey points are from 15 to 20 miles apart.

Each signaller works from three different points on the hill or range forming his particular station, and transmits his flash from one or the other, according to the fluctuations of the Calcutta market, and the original telegram received at Ajmere; the right-hand point representing prices rising, the left falling, the centre stationary. No other attempt at a code is attempted, but the rapidity with which the flashes are transmitted is wonderful, and worthy of a professional heliotroper. The expenses of the telegraph are defrayed by the various banking firms *en route*, and the subscription to the fund is Rs. 50 a month.

The border of Bickaneer to the north of Nagore marks the re-commencement of the sand ridges, which here rise to a considerable height, and stretch almost up to the capital of the district—the city of Bickaneer.

The survey of this portion of Rajputana hereafter by the Geological Survey will, no doubt, lead to some interesting theories concerning the lost rivers of "Rajput celebrity." Bickaneer itself stands upon a bed of conglomerate, overlooking what at a distance has all the appearance of a broad river-valley. The formation is very similar to the hills round Joodhpoor where the upheaval of the boulders has been much more violent, but the same evidence of the existence in past centuries of a considerable river exists.

For some distance along this valley, east and west of the city, the ground is hard and stony, and the imaginary bed continues; but at a distance of 10 miles all trace of it is lost in the sand, and the ridges again rise one behind the other with the same uniform regularity as over the country to the north and south.

The capital presents few points of interest. There are no natural features as at Joodhpoor to add to the picturesqueness of a few temples and mosques surrounding the city, and the bastioned wall and palace show considerable decay and want of repair.

It is the residence of the Maharajah and head-quarters of the Sujangarh agency.

From various accounts the country lying between Bickaneer and Bhawalpore, which remains for survey, will present no great difficulties during the cold season. It is uninteresting to a degree, but it is during the hot months, before the rainy season sets in, that it is unhealthy.

Major Walter, the Political Agent at Joodhpoor, last year marched from Nagore westwards to Jeysulmeer, and describes the country through which he passed as very similar to the tract I have described.

Extract from the Narrative Report of CAPTAIN J. R. MCCULLAGH, R. E., *in temporary charge No. 8 or Mysore Topographical Survey Party.*

Captain G. Strahan left Bangalore to take the field on the 4th of December, accompanied by Messrs. McNair, White and Fleming, to undertake the survey of the Kankanhalli State Forest. Mr. McNair undertook the reconnaissance and triangulation of it, and finished it by the 24th December, fixing 55 points by observations at eight stations, based on the Great Trigonometrical sides of Banatmari to Kopabetta and Banatmari to Devarabetta, the majority of points being fixed by more than two rays and having their heights also measured. The signals were for the most part red and white flags on trees, as the hills are covered with dense forest, and poles were found to be of little use.

Captain Strahan, assisted by Messrs. White and Fleming, meanwhile traversed the boundary of the forest 35 miles in length, and on the 22nd December, having finished the field work, commenced the computations thereof. By the 1st January all the computations of triangles, latitudes and longitudes, heights, and traverses were finished, and the four boards on which the detail survey was to be laid down mounted and projected and made over to Messrs. White and Fleming. The scale of the survey is 4 inches to the mile in accordance with the wishes of the Forest Departmental authorities, and eye contours at 50 feet vertical intervals have been inserted as nearly as is practicable without resorting to actual levelling operations. The numerous heights given by the triangulation rendered this comparatively easy. Messrs. White and Fleming have worked well, and accomplished satisfactorily a somewhat troublesome and difficult piece of work.

Captain Strahan then returned to Degree Sheet VIII, and observed at some stations in Sheets 41 and 42 which had been reconnoitred and prepared the previous season in anticipation of its being found impossible to proceed with 37 and 38. This with Mr. Stotesbury's and Mr. Knight's help was computed then and there and the boards projected. He then reconnoitred and observed the northern half of Degree Sheet XII, and brought the season to a close on the 1st April.

In entering into the detail of work performed by the Surveyors, Assistant Surveyors and Sub-Surveyors during the past field season, I quote verbatim from the memoranda left by Captain Strahan; and as regards the office duties, I would beg to add that I have found one and all of the assistants most attentive and diligent in the discharge of their duties. The unfortunately, but yet unavoidably, disconnected and incomplete state of the field work naturally led to a certain amount of difficulty in distributing for any length of time together the various duties to be performed in office, but every change has been met with cheerfulness and a desire to please, which has given me much satisfaction.

"Mr. Chew left Bangalore on the 28th November, and reconnoitred Sheets 35, 36, 39, 40, and commenced observing on 29th January. He carried on his observations till 4th March, when he was forced to retreat by the prevalence of virulent cholera in that district; and in order to employ the time till field work was no longer possible, completed the reconnaissance of Sheet 42, and also a portion of Sheet 46, and returned to Bangalore on 5th April."

The country worked over is of the same general character as appertains to the greater part of Mysore, being chiefly undulating, varied by hills, sometimes in groups, sometimes isolated, of great diversity of shape and size. In the more level portions, moving about is comparatively easy, but in the hilly tracts locomotion is most difficult, and can only be accomplished with the aid of pack-bullocks or coolies.

The chief towns and forts within the areas surveyed are Bangalore, the seat of government of the Mysore Province, which is so well known as to need no description, Tumker, the head-quarters of the district bearing that name, and the hill fort and sanitarium of Nundydroog. This latter is situated at an elevation of 4,800 feet above sea level, and was at one time a place of considerable strength until taken by the British troops. The fort is now more or less in ruins, but the hill is resorted to in the hot weather months by a few of the residents of Bangalore.

The field season was one of short duration, but owing to the great scarcity of the necessaries of life, food and water, was of a peculiarly trying nature, and it proved to be so unhealthy as to tell severely on the members of the party, both Europeans and Natives. Messrs. Farrell, Kitchen, Barker and McNair all suffered from sickness, which prevailed in one form or other over nearly the whole country. There were five deaths from cholera amongst the Native establishment and camp followers, and much illness in the shape of fever and bowel complaints. The Native establishment, with the exception of the Hindustani element (15 men lent from No. 7 Topographical Party, who have since been returned), does not appear to have worked well or given satisfaction. Out of an average strength of 132 men there were no less than 39 desertions, and 7 others were discharged for misconduct during the space of three months, and at the close of the season another lot of 50 men were not considered worthy of being kept on the rolls. With such materials it is evidently impossible to carry on work in a satisfactory manner, but I hope to be able to introduce for next season the same class of men who have done so well in No. 9 party, should work in the usual manner be found practicable.

Extract from the Narrative Report of CAPTAIN J. R. MCCULLAGH, *in charge No. 9 Mysore Topographical Survey Party for season 1876-77.*

In proceeding to make a few remarks on the country through which the operations were carried, I would premise that being so well known to the European officers of the Government, there seems no need to enter into details of appearance, products, people, &c., the most minute information on all these matters being doubtless in the possession of the Statistical Department. I will therefore confine myself to observations from a professional point of view. The part of the country included in Degree Sheets I and II is for the most part hilly, though comparatively level ground is also to be met with. Large tracts of dense forest are a source of much inconvenience and delay to the surveyor, who is first obliged to clear hill tops for his stations of observation and for intersected points, as a groundwork for subsequent traverse operations, previous to the sketching of the ground.

In the more jungly portions the villages are widely scattered and are small in size; in fact they are in some places little more than a collection of hamlets of a few houses in each; it is, in consequence, more difficult to get about and to procure assistance in the way of labor and supplies than in other more open and populated parts of the country.

In Sheets XI and XIV the ground is comparatively open, with numerous isolated hills of all shapes and sizes; but though well adapted as regards position, they are very often of a most inconvenient description for stations of observation, their summits being crowned with a collection of sharp-pointed rocks sufficiently high to obstruct the view, and yet too narrow to admit of an instrument being set up on them. Along the western margin there is a strip of almost impenetrable jungle, and here also the population is scanty and the villages few and small.

The part of the country topographically surveyed in sheet IV is open and populous; the hills are mostly isolated, and in places very precipitous; the rest of the ground is extremely undulating to the eye; but the swells are not of sufficiently marked character to admit of delineation as a rule on so small a scale. The numerous water-courses, however, show the general slope and fall of the ground.

The only towns and forts of importance met with were those of Mysore and Seringapatam; the former has a population of about 57,000, and is the residence of His Highness the Maharajah of Mysore, whose principal Palace is within the *enceinte* of the fort. Of the fort itself, there is little to be said beyond that whatever it might have been in former days, its strength has departed in the face of modern ordnance, and it is completely commanded within effective range. The importance of Seringapatam, I think, may be said to lie only in the historical associations connected with the place. A moderate-sized village is contained within the defences, which are in a ruinous condition; and as far as I saw, there is not a single gun mounted or dismounted on the ramparts. There is no garrison of any sort, unless a few of the rural police may be considered such. Opposed to modern ordnance, the fortress appears to me incapable of resistance for a single day.

APPENDIX E.

GEOGRAPHICAL, COMPILING AND DRAWING BRANCHES, SURVEYOR GENERAL'S OFFICE.

Statement showing the nature of the work performed, and the progress made from 1st October 1876 to 30th September 1877, twelve months.

MAPS.	SCALE. Miles. Inch.	REMARKS AND PROGRESS.
INDIA—Standard original in 6 sheets (outline).	32 = 1	Additional materials from the several surveys current, reduced and inserted.
INDIA—6 sheets (outline). ...	32 = 1	Blue print reproduction of the above Standard. Sheet 3 (Rajputana) in progress. Sheet 5 (Madras) completed for engraving; under examination. Sheets 1 and 4 engraving.
INDIA No. 3.—4 sheets (outline) ...	64 = 1	Reduced from the above Standard. The hill drawing in progress and well advanced towards completion.
BENGAL—Standard (outline) in 2 sheets.	16 = 1	Engraving. The principal names (new spelling) inserted on dry prints of the outline for a preliminary issue.
BENGAL—Trade map of ...	16 = 1	Drawn on blue prints of the Standard 16 mile compilation, for Photozincography. For the Bengal Government.
BENGAL—Postal map of ...	16 = 1	A new Postal map of the Bengal Circle, 1878, under preparation for the Post Master General of Bengal, from information being supplied from time to time by the Postal Department. Completed as far as received. In progress.
ASSAM—Standard compilation in 8 sheets.	8 = 1	Sheets 1 and 2 being Lithographed. Additional materials to date inserted in sheet 3, (Lakhimpur and Sibsagar districts, with surrounding country of the various hill tribes); waiting further additions to complete. Sheets 4, 5, 7 and 8 (in one), completed.
SIND—The Province of ...	16 = 1	Hills drawn on a dry print proof for Lithography.
RAJPUTANA AGENCY—2 sheets (outline).	16 = 1	Standard projections made for engraving on copper. Compiled and drawn in outline from recent surveys as far as received; subject to yearly additions to complete on receipt of further survey materials. Under examination.
CENTRAL INDIA AGENCY—2 sheets (outline).	16 = 1	
CENTRAL PROVINCES—2 sheets (outline).	16 = 1	Standard projection made for engraving. Under compilation in outline from recent surveys; in progress and well advanced.
KELAT—The Khanate of—or Baluchistan.	16 = 1	Further additions and corrections made to date, and last proofs revised and completed for press order.
BHUTAN—Preliminary map of ...	8 = 1	Further additions and corrections made to date for a new edition.
Countries between Hindustan and the Caspian Sea.	64 = 1	Further additions and corrections made to date, and last proofs of outline revised and completed for press order. Hills drawn on a dry print proof complete for Lithography.
District Maps.		
CHITTAGONG DISTRICT, ...	4 = 1	Hills revised for a new edition.
HOSHANGABAD DISTRICT, ...	4 = 1	Pargana Borda, transferred to this district, added on original compilation.
CAWNPORE DISTRICT, ...	8 = 1	Drawn for Gazetteer, North-Western Provinces.
AJMERE DISTRICT—6 sheets, ...	1 = 1	Prepared and completed with boundaries, &c., from the 1 inch sheets of the Rajputana Survey.
MHAIRWARA DISTRICT—4 sheets ...		
DISTRICTS,— Bahraitch, Balasore, Barabanki, Darbangah, Fyzabad, Gondah, Hardui, Kheri, Lucknow, Monghyr, Mozufferpore, Partabgarh, Puri, Rai Bareli, Sitapur, Sultanpoor Unao, ...	4 = 1	Extracted from the Atlas of India, and prepared and completed for publication with the latest information to date.
Index Maps.		
INDIA—No. 2, ...	128 = 1	Two copies prepared for Departmental Reports of 1875-76 and 1876-77, representing the various surveys completed and in progress.
INDIA—No. 3, ...	64 = 1	Showing the portions surveyed, published, and in course of publication by the Topographical Trigonometrical, and Revenue Surveys under the control of the Surveyor General of India, and Superintendent, Great Trigonometrical Survey to 1877, prepared for the Intelligence Committee; 2 copies, one for record.
INDIA—Sketch map of ...	32 = 1	Additional information supplied by Captain Collen, of the various passes, military roads, bridges, &c., throughout India, embodied in two copies, one for the Military Department, the other for record.
INDEX to the sheets of the Atlas of India.	128 = 1	Three copies prepared, showing the state of the engraving and publication for 1876 and 1877 (one for the Intelligence Committee).

Maps. (*Continued*).	Scale.	Remarks and Progress.
Index to the sheets of the Gwalior and Central India Survey. Khandesh and Bombay Native States Survey. North-Eastern Division, Central Provinces Survey. Central Provinces and Vizagapatam Agency Survey. Bhopal and Malwa Survey. Khasi, Garo and Naga Hills Survey. Rajputana Survey. Mysore Survey.	32 miles = 1 inch.	Revised for seasons 1875-76 and for 1876-77, to illustrate the publication of the sheets, and progress of the several Topographical Surveys named.

Cantonments.—Boundaries of the following Cantonments reduced and inserted, to complete the recorded set of office Atlas Sheets which show them, *viz.*, Aligarh, Bannu, Cawnpore, Debra, Dera Ghazi Khan, Dera Ismail Khan, Ferozepore, Jhansi, Jullundur, Jutog, Kasauli, Lahore, Lucknow, Meean Meer, Meerut, Murree, Nagode, Nowgong, Peshawur, Rawalpindi, Sealkot, Sultanpoor, Umballa.

SHEETS OF THE ATLAS OF INDIA, 4 MILES = 1 INCH.

Sheets 12 (four quarters), 13 (four quarters), 18 (four quarters), 34 S. W., 36 N. E., 37 S. E., 71 N. E., 92 S. W., 94 S. E., 130 N. E., 131 N. E. and S. E.	Points projected on dry prints of the sheets named.
„ 12 N. E.* and S. E.* ...	Parts of Cutch and Kattywar, drawing in outline from recent surveys, completed of S. E. and N. E. drawing in progress.
„ 17 full plate ...	Part of Bhawulpore reduced from the sheets of the Revenue Survey. Drawing completed of 17; 18 N. W., drawing in progress.
„ 18 N. W.* ...	
„ 22 S. W. and S. E. ...	Part of Kattywar. Drawing in outline from recent surveys completed of S. W.; S. E. in progress.
„ 23 N. W.	Part of Kattywar. Hill drawing in progress.
„ 33 S. E. and S. W.* ...	Parts of Ajmere and Jeypore, 33 S. E., drawn complete with hills. S. W. drawing in progress.
„ 34 N. E., N. W. and S. W. ...	Parts of Ajmere, Oodeypore and Jodhpoor. N. E., N. W. and S. W., drawn complete with hills.
„ 35 N. E. and S. E.	Parts of Jhalawar, Neemuch, Oodeypore, &c. Drawing in outline from recent surveys completed of N. E.; S. E, drawing in progress.
„ 36 S. E. and N. E.* ...	Parts of Khandesh and Native States in Central India. Drawing in outline from recent surveys made to date. In progress.
„ 37 N. E. and S. E.* ...	
„ 52 N. W. and S. W. ...	Parts of Native State in Central India. N. W. and S. W., drawn complete with hills.
„ 66 full plate ...	Parts of Kumaon and Garhwal. Drawing in outline completed to extent of materials received from the Great Trigonometrical Survey.
„ 67 „ ...	
„ 71 N. E. and S. E.	Parts of Mandla. Drawing in outline of additions from recent surveys, to complete. In progress.
„ 74 full plate	Part of Ahiri zamindary added, and hills drawn complete.
„ 90 S. W.	Parts of Mandla and Raipur, Central Provinces. Drawn in outline from recent surveys. Hills wanting; in progress.
„ 91 N. W.* and S. W.* ...	Parts of Raipur, Balaghat and Mandla, Central Provinces. Drawn in outline. Hills wanting; in progress.
„ 92 N. W. and S. W. ...	Parts of Raipur, Chanda and Bastar, Central Provinces. Drawn in outline. Hills wanting; in progress.
„ 93 N. W.	Parts of Bastar and Godavari Taluks. Additions of new material from recent surveys, compiled and drawn in outline to complete. Hills wanting; in progress.
„ 95 N. W.*	Part of Masulipatam, Madras Presidency. Recent work of the Madras Revenue Survey, reduced and drawn complete for re-engraving.
„ 113 full plate	Hills drawn complete on a dry print proof of the added portion of Hazaribagh.
„ 124 N. E., N. W., S. W., S. E. ...	Parts of Goalpara, Darrang, Kamrup and Nowgong. Remaining outline and hills compiled and drawn complete.
„ 125 S. E.	Parts of Sylhet and Cachar, revised and blank portions compiled and drawn with hills complete from recent surveys.
„ 130 N. W. and S. W. ...	Part of the Naga Hills, Nowgong, Lakhimpur and Sibsagar. Further additions to date made from recent surveys; complete with hills.

*The sheets marked thus *are new sheets.

STANDARD SHEETS OF THE TOPOGRAPHICAL SURVEY, RE-DRAWN FOR PHOTOZINCOGRAPHY.

Chota-Nagpore Division Survey.	Miles.	Inch.	
Sheet 54½	1	= 1	Corrections and additions made for a second edition.
Ganjam and Orissa Survey.			
Sheets 30, 31, 32, 33, 46 and 48 ...	2	= 1	Fair drawn from the original field sheets.
„ 41, 43, 52	1	= 1	Projected and fair drawn from the original field sheets.
„ 62, 63, 64, 65, 66 and 67 ...	1	= 1	Projected and in progress in various stages.

MAPS. (*Continued*).	SCALE. Miles. Inch.	REMARKS AND PROGRESS.
Central Provinces and Vizagapatam Agency Survey.		
Sheets 12 and 14	1 = 1	Projected and in progress in various stages.
Rewah and Bundlekund Survey.		
Sheets 12 and 32	1 = 1	Corrections and additions made for a second edition.
Simla and Sutog Survey.		
20 sheets	1 = 24	Insertion of estate boundaries, and examination and revision of originals for a new edition to 1876. The remaining 8 sheets completed.
Rajputana Survey.		
Sheets 26 and 31	1 = 1	Corrections and additions made for a third edition.

MISCELLANEOUS MAPS.

INDIA, Military map of ...	60 = 1	Showing disposition of the army, army corps, &c., &c. Six copies revised for the Military Department and returned.
Country within a radius of 20 miles round Umball aand from Umballa to Kalka.	1 = 1	A trace made on vellum cloth from the original one-inch sheets of the Revenue Survey, for reproduction.
Districts Ellichpur, Akola, Amraoti, Bassim and Yeotmal, with part of Hyderabad.	1 = 1	Traces made on vellum cloth of parts of Hyderabad and the districts named, from the original field sections of the Hyderabad Survey, for the use of the Forest Department.
District Rohtak.	1 = 1	Tracing made on Vellum cloth of the pargana boundaries of this district for the Settlement Officer.
District Mainpuri.	2 = 1	Two copies made for the Settlement Officer, one showing the principal villages only, the other showing all the villages of the district.
The Portuguese Territory of Goa. ...	1 = 1	A trace made on vellum cloth of the Goa Territory, for the Marine Survey Department.
Palni Hills. Sketch map of the. ...	4 = 1	Extracted from sheet 62 of the Indian Atlas for re-production.
Sundarbans Survey.		Extracts made from various old field books, sections and maps of this survey, bearing on lots 100 and 104, and areas of the same taken out for the High Court and the Superintendent, Revenue Surveys.
Soondoor Jaghir, Madras Presidency, season 1842.	2 = 1	Copy of the same made on vellum cloth for the use of the Collector of Bellary.

Charts of Triangulation, 4 miles = 1 inch, of the

Chota Nagpore Division Survey seasons	1862 to 1865.	Extracts on vellum cloth made from these charts, and a synopsis of latitudes, longitudes and heights of the several points therein, prepared for the Superintendent, Revenue Surveys.
Rewah and Bundelkund „ „	1865 „ 1866.	
Jhelum and Rawal Pindi „ „	1855 „ 1859.	
Ganjam and Orissa „ „	1858 „ 1859.	
South Parasnath series „ „	1850 „ 1852.	

Blank projections for a map of Afghanistan, in Degree Sheets,	4=1	Forty-six single Degree Sheets on the scale of 4 miles=1 inch, between the parallels of 28° and 38°, and meridians of 61° and 71°, and the same area in four sheets on the scale of 16 miles=1 inch, projected with card scales for the projection of points on the same, for Major J. Brown, R. E., Mooltan.
The same in 4 sheets, ...	16=1	

Examination, corrections and additions to original survey sheets, maps, charts, &c., } 238 original sheets examined, corrected and touched up for re-production and engraving.

Examination, corrections and additions to engraved, lithographed and photozincographed proof maps. Various. } Blanks filled up, railways, boundaries, territorial names, headings, foot-notes, titles, &c., inserted, examined, completed and corrected in 5,271 sheets.

Atlas Sheets and engraved maps colored—4,969 sheets.
Lithographed and photozincographed maps and plans, colored—23,769 sheets.

J. F. BANESS,
Surveyor and Chief Draftsman,

J. O. N. JAMES,
Assistant Surveyor General, in charge Drawing Branch.

10th December 1877.

APPENDIX F.

ENGRAVING BRANCH, SURVEYOR GENERAL'S OFFICE.

Annual Progress Report up to 31st December 1877.

Atlas Sheet No.	23 S. W. ...	New sheet completed full up to margin.
,,	52 N. W. ...	Ditto ditto.
,,	72 N. W. ...	Ditto ditto.
,,	72 N. E. ...	Ditto ditto.
,,	93 S. E. ...	Ditto ditto.
,,	93 S. W. ...	Ditto ditto.
,,	105 S. W. ...	Ditto ditto.
,,	124 S. E.	Ditto ditto.
,,	124 S. W. ...	Ditto ditto.
		NEW SHEETS TO WHICH LARGE ADDITIONS FROM FRESH SURVEYS HAVE BEEN MADE, OR ARE IN PROGRESS.
,,	33 S. E. ...	Large addition of new survey, outline writing and hills up to margin; plate finished.
,,	34 N. E. ...	Large addition of new survey, outline writing and hills up to margin; plate finished.
,,	53 S. E. ...	Large addition of new survey, and outline writing done up to margin; hills just commenced; in progress.
,,	130 S. W. ...	Outline and writing of new survey done; hills 1-10th completed; in progress.
,,	131 S. W. ...	Hills of new survey commenced; plate put down for more urgent work.
,,	125 S. E. ...	Taking out old work and re-engraving new survey; outline writing and hills finished.
,,	91 S. E. ...	Taking out and re-engraving; new additions finished.
		NEW ATLAS SHEETS IN HAND.
,,	12 S. E. ...	Border and projections done; outline of new survey one-fourth done; in progress.
,,	22 S. W. ...	Border and projections done; outline of new survey half done; in progress.
,,	22 S. E. ...	Border and projections done; outline done as far as drawing; writing just commenced; in progress.
,,	23 N. W. ...	Outline and writing done full up to margin; transfers for preliminary edition have been taken; waiting drawing for hills.
,,	34 N. W. ...	Outline and writing up to margin completed; transfers for preliminary edition have been taken.
,,	34 S. W. ...	Outline and writing up to margin done; transfers for preliminary edition have been taken; hills in progress; one-eighth completed.
,,	35 N. E. ...	Outline done up to margin; writing just commenced.
,,	35 S. E. ...	Outline done as far as drawing; ditto ditto.
,,	36 S. E. ...	Ditto ditto ditto ditto.
,,	37 N. E. ...	Ditto ditto writing half done; in progress.
,,	52 S. W. ...	Outline and writing up to margin done; transfers for preliminary edition have been taken; hills just commenced; in progress.
,,	72 S. W. ...	This quarter sheet was cut out of, and made up from, the old full Degree Sheet 72; heavy additions done.
,,	90 S. W. ...	Outline and writing up to margin completed; transfers for preliminary edition will be taken as soon as examined.
,,	92 S. W. ...	Outline up to margin done; writing half completed; in progress.
,,	93 N. W. ...	Outline up to margin in progress.
,,	95 N. W. ..	Ditto ditto done; writing half completed; in progress.
,,	124 N. W. ...	Taking out old work and engraving new survey; outline and writing done; hills will be put in hand as soon as possible.
,,	124 N. E. ...	Outline and writing done; transfers for preliminary edition have been taken; hills will be put in hand as soon as possible.
,,	125 N. W. ...	Outline and writing done; hills almost finished; plate put down on account of sickness of the hill etcher.

Atlas Sheet No.	130 N. W.	... Outline and writing up to margin done; copies of preliminary editions taken from the plate; hills in progress; plate put down for a short time on account of more urgent work.
,,	91 N. W.	... Outline up to margin half done; in progress.
,,	91 S. W.	... Ditto ditto ditto ditto.

OLD PLATES TO WHICH LARGE ADDITIONS HAVE BEEN MADE, OR ARE IN PROGRESS.

,,	17	... Large additions of new survey outline; writing and heavy sand-hills done; jungle in progress; almost done.
,,	31	... New survey outline, writing, sand-hills, &c., finished.
,,	73	... Heavy additions of new survey outline, writing, hills and jungle done; plate finished.
,,	74	... Heavy additions of new survey outline and writing done; hills half completed; in progress.
,,	94	... Hills of heavy portion of new survey done; repairing hills to match the new work in progress.
,,	103	... Heavy alterations; re-engraving parts taken out of outline; writing, &c., finished.
,,	108	... Outline, writing and hills of new survey done; repairing old work; plate put down for other work.
,,	113	... Heavy additions of new survey outline and writing done; hills will be commenced as soon as possible.
,,	119	... Heavy additions of new survey done; outline, writing, hills and jungle done; plate finished.
,,	121	... Heavy additions of new survey of the Sunderbuns outline; writing done; jungle in progress; plate put down for more urgent work.
,,	106	... Heavy additions and corrections almost finished; plate put down for a short time.

SHEETS REPAIRED TO WHICH SMALL ADDITIONS AND CORRECTIONS HAVE BEEN MADE, OR ARE IN PROGRESS.

Atlas Sheets 1 N. E.; 1 S. E.; 2 S. E.; 2 S. W.; 3 N. E. 3 N. W.; 3 S. E.; 5 S. E.; 5 N. E.; 6 N. E.; 6 S. E.; 8 S. E.; 8 S. W.; 9 N. E.; 9 S. E.; 9 S. W.; 10 S. E.; 10 N. W.; 10 N. E.; 11 N. E.; 11 N. W.; 11 S. E.; 11 S. W.; 27 N. E.; 27 S. E.; 32 S. E.; 32 N. E.; 32 S. W.; 33 S. W.; 33 N. E.; 34 S. E.; 44 N. W.; 45 S. W.; 45 N. W.; 51 S. W.; 51 N. W.; 51 N. E.; 51 S. E.; 52 N. E.; 53 N. E.; 53 S. W.; 69 N. W.; 69 S. W.; 69 S. E.; N. E. and N. W.; 70 S. W.; 70 S. E.; 70 N. W.; 71 N. W.; 72 S. E.; 86 S. W.; 87 N. W.; 87 S. W.; 87 S. E.; 87 N. E.; 92 N. E.; 92 S. E.; 93 N. E.; 105 N. E.; 105 S. E.; 105 N. W.; 125 N. E; 126 S. W.; 126 N. W.; 126 N. E.; 126 S. E.; 127 N. E.; 127 S. E.; 127 N. W.; 127 S. W.

SLIGHT ADDITIONS AND REPAIRS TO OLD SHEETS.

,,	4	... Slight additions, price, &c.
,,	7	... Ditto ditto.
,,	16	... Ditto ditto.
,,	24	... Slight additions, railways, boundaries, price, &c.
,,	25	... Ditto ditto ditto.
,,	26	... Repairing, writing completed.
,,	30	... Slight additions, price, &c.
,,	38	... Ditto ditto.
,,	39	... Ditto names, railways, roads and title done.
,,	40	... Ditto ditto ditto ditto.
,,	41	... Repairing outline, in progress; thee-fourths completed.
,,	43	... Ditto writing completed.
,,	46	... Slight additions, price, &c.
,,	47	... Ditto repairing, writing in progress.
,,	48	... Heavy sheet ditto ditto.
,,	49	... Taking out and re-engraving railways; corrections and writing done.
,,	50	... Engraving railways; station names, and corrections completed.
,,	56	... Repairing outline and writing; in progress.
,,	57	... Ditto ditto completed.
,,	58	... Ditto ditto in progress.

Atlas Sheet No. 60 ...	Outline repaired; writing being recut; in progress.
„ 61 ...	Repairing outline and writing completed.
„ 62 ...	Ditto ditto plate put down for other work.
„ 63 ...	Ditto ditto and writing completed.
„ 76 ...	Ditto ditto ditto half done.
„ 79 ...	Ditto writing completed.
„ 95 ...	Ditto ditto.
„ 102 ...	Engraving; district names, price, &c., completed.
„ 104 ...	Slight additions, price, &c.
„ 114 ...	Repairing writing; about one-fourth done; in progress.
„ 115 ...	Ditto ditto ditto.
„ 116 ...	Slight additions, price, &c.
„ 118 ...	Ditto ditto.
„ 120 ...	Ditto ditto.
„ 129 ...	Ditto ditto.
„ 138 ...	Ditto ditto.

THE FOLLOWING ATLAS SHEETS HAVE BEEN PROJECTED AND BORDERS CUT.

Atlas Sheets 18, 19, 20, 75, 76; all four quarters; 94 S. E. and 108 N. E. In all 22 plates; and borders cut only to five blank plates.

GENERAL AND MISCELLANEOUS MAPS AND OTHER WORK COMPLETED AND IN PROGRESS.

Map of India in 6 sheets; scale 32 miles=1 inch, sheet 1.	Outline and writing completed as far as first orders.
Map of India in 6 sheets; scale 32 miles=1 inch, sheet 4.	Outline done; writing well advanced.
Map of Sind, 16 miles=1 inch.	Outline and writing completed; map published, preliminary edition.
Map of Bengal in 2 sheets, 16 miles=1 inch.	Sheet 1, outline done; writing nearly completed as far as first orders.
Map of Bengal in 2 sheets, 16 miles=1 inch—sheet 2.	Ditto ditto done as far as first orders.
Map of India, scale 96 miles=1 inch, skeleton.	Outline done; writing just commenced.
Map of Assam, 16 miles=1 inch.	Outline and writing completed; corrections and additions in progress.
Map of Oudh, 16 miles=1 inch.	Finished and published.
Map of Central India in 2 sheets; scale 16 miles=1 inch.	Border and projections done.
Map of Rajputana, in two sheets, scale 16 miles=1 inch.	Border and projections just commenced.
Large Graticule Brass Plate. ...	For the Trigonometrical Survey—completed.
Commission plate for the Military Department.	Taking out old work, and engraving new wording for commissions of native officers; completed.
Skeleton map of the Punjab, scale 32 miles=1 inch.	Heavy additions and alterations completed up to date.
Map of India, 80 miles, in 2 sheets	Outline done; writing just commenced.
Anemograph scale.	For the Mathematical Instrument Department; finished.

GAZETTEER MAPS.

Bhagulpur Division... ...	Finished.
Chota-Nagpore Division. ...	
Rajshahi and Kuch Behar Division.	
Patna Division.	
Chittagong Division ...	
Map of Orissa.	Corrections completed.
Four sheets, plan of Calcutta 'Simms.'	Slight additions completed.
Steel Guage.	Engraved for the use of the Telegraph Department; finished.
Scales of latitudes and longitudes for the use of the Indian Atlas.	A new scale engraved; finished.
Ten scales of 2½ chains to the inch or 32 inches to the mile.	Engraved for the Mathematical Instrument Department; finished.

1 Large tint of dots	For transfers for printing in colours; finished.
5 Small do. ...	Ditto ditto ditto.
Rain scale in 100ths of an inch ...	Engraved for the use of the Mathematical Instrument Department.
Six plates of imprints, ...	With new additions and alterations of dates.

NUMBER OF PLATES IN HAND.

1877	230

COPPER-PLATE PRINTING.

Proofs, ...	1,129
Transfers, ...	691
Impressions, ...	9,687
TOTAL IMPRESSIONS ...	11,507

C. W. COARD,
Supdt., Engraving Branch,
Surveyor General's Office.

JOHN O. N. JAMES,
Assistant Surveyor General,
In charge Engraving Branch.

SURVEYOR GENERAL'S OFFICE,
Calcutta, 31st December 1877.

APPENDIX G.

From CAPTAIN J. WATERHOUSE, *Assistant Surveyor General, in charge Photographic Branch, to the Surveyor-General of India, No. 483 P., dated Calcutta, 15th December 1877.*

I have the honor to forward the usual tabular statements showing the amount and progress of the work performed in this branch of your, office during the past year from 1st October 1876 to 30th September 1877.

2. AMOUNT OF WORK.—The amount of work performed during the year under report, as compared with the previous year, is shown in the following table :—

	Ordinary Work.				Cadastral Maps, North-Western Provinces.			
	1st October 1875 to 30th September 1876.	1st October 1876 to 30th September 1877.	Difference.	Difference in square feet.	1st October 1875 to 30th September 1876.	1st October 1876 to 30th September 1877.	Difference.	Difference in square feet.
Originals	955	1,244	+289	...	1,270	2,009	+739	...
Negatives ...	1,141	1,565	+124	...	3,133	4,334	+1,201	
	2,776·4 *s. f.*	3,046·76 *s. f.*		+270·36	6,890·59 *s. f.*	11,211·44 *s. f.*	...	+4,320·85
Silver prints ...	1,264	871	−390		.....	.....	...	...
	1,621·288 *s. f.*	1,361·22 *s. f.*		−260·06				
Photo. Transfers	1,297	1,663	+366		3,363	4,350	+987	
	2,289 *s. f.*	3,208·64 *s. f.*		+928·64	7,102·04 *s. f.*	11,646·44 *s. f.*		+4,544·4
Transfers to zinc or stone ...	518	672	+154	...	1,337	2,021	+684	...
Number of pulls ...	138,858	144,184	+5,326	...	56,200	*97,000	+40,800	...
Ditto sheets ..	175,218	148,665	−26,553	...	56,200	97,000	+40,800	...
Ditto copies ...	160,935	133,318	−27,617	...	29,700	65,900	+36,200	...
Carbon prints of life convicts	1,840	3,132	+1,292	...	.....	.....	...	...

* 1,490 sheets printed off.

3. PROGRESS.—The number of original subjects received as the ordinary work of the office shows a considerable increase, though the out-turn of the presses is less. As will be shown further on, considerable progress has been made in the reproduction of the Cadastral maps of the North-Western Provinces, and the out-turn is very much larger than in the previous year. A very large amount of work has been done for other Departments, the details of which are shown in the accompanying table.

4. EXPENSE OF WORKING.—The expense of working the office during the financial year 1876-77 is shown, as far as materials are available, in the following table :—

	Rs. As. P.	Rs. As. P.	
Superintendent's salary from April 1876 to 31st March 1877	13,050 0 0		
Sanctioned Establishment	22,096 14 6		
House-rent	4,188 3 0		
Contingencies	2,066 0 3		
		41,401 1 9	
Cadastral Establishment, North-West Provinces ...	9,789 8 3		
Cadastral Contingencies	1,564 3 3		
Cadastral Contingencies additional for construction of glass-house,* &c.	248 11 0		* Rs. 4,000 was paid on this account from Grant of 1875-76.
Cadastral extra work	4,638 10 7		
		16,241 1 1	
Chemicals and stores received from England as far as known	31,447 11 6 †		† These sums include cost of materials, &c., received for the Cadastral work.
Chemicals received from Government Medical Stores ...	303 9 0 †		
Stores and Materials received from other Government Departments	570 4 6 †		
Cost of paper	18,121 3 1 †		
		50,442 12 1	
GRAND TOTAL ...		1,08,084 14 11	

5. The expenditure on the office establishment and contingencies has been less by upwards of Rs. 2,000 than it was last year. The expenditure for the Cadastral establishment was much larger than the previous year, owing to the increase of establishment; and the expense of chemicals, paper and stores received from England was also largely increased by the requirements of the Cadastral Surveys. These items, however, do not affect the Departmental Budget.

6. The expenditure upon the reproduction of the Cadastral Survey maps of the North-Western Provinces during the financial year 1876-77, amounting, as shown in the foregoing table to Rs. 16,241, was met from the grant of Rs. 20,000 given by the North-Western Provinces Government for that purpose, but during the greater part of the year the full establishment was not engaged. With a few exceptions the full establishment has now been entertained as follows:—

3 Photographers; 5 Assistant Photographers, (2 Vacant); 2 Glass cleaners; 5 Labourers; 4 Negative retouchers; 1 Zincographer; 7 Zinc printers (1 vacant); 20 Pressmen; 4 Zinc grainers; 8 Zinc correctors; 1 Head Assistant (vacant); 1 Store-keeper and Accountant; 1 Writer; 1 Record-keeper; 1 Carpenter and 1 Farash, or a total of 65 men, and the cost of it will be met from the grant given by the Government of the North-Western Provinces, amounting for the present financial year to Rs. 28,000.

7. Some of the posts have not yet been filled up, because I have been unwilling to entertain the full establishment until I was in a position to turn out the full number of sheets required and estimated for. That time has now arrived, and I shall take steps to complete the establishment to full strength, and to strengthen it further in those branches which experience has shewn to be too weak to deal with the work they have to do.

8. PERSONNEL.—With the exception of the resignation of his appointment on the Cadastral Establishment by Mr. A. Madge, no changes took place in the European Staff of the office during the period under report; but Mr. G. G. Dempster, who was transferred to this office from the Great Trigonometrical Survey Office, in consequence of reduction of establishment, joined the Cadastral Staff in place of Mr. Madge on the 1st October. The senior assistants, Messrs. J. Mackenzie, B. Mackenzie, Watson, Harrold and Marshall, have continued to give every satisfaction in the discharge of their respective duties, and the junior assistants, Sergeant George, Messrs. Lagnier, Leroy and LeFranc have made good progress in learning the work connected with the reproduction of the Cadastral survey maps. A great deal of heavy work in bringing up the store accounts devolved upon Syud Ishmael, the store-keeper, and he and the native assistants have done well.

9. CADASTRAL MAPS OF THE N.-W. PROVINCES.—Considerable progress has been made in the work of reproducing these maps during the year, and, 1,940 sheets have been printed off. The presses indented for specially for this work were received from England in October 1876, but the large cameras, lenses and apparatus did not arrive till the months of June and July 1877, and all arrangements were completed for commencing work with them about the middle of August. Before the arrival of the special presses and cameras from England, a great deal of the cadastral work had to be done as extra work out of office hours and paid for extra, as shown in the table in paragraph 4, under the item "cadastral extra work," because the photographic and printing plant at my disposal did not admit of the work being done in any other way, and I was anxious to make some progress with the work, to utilize the chemicals and stores received for it and to get the young hands trained. There is now no necessity for extra work, except in cases of urgency, and it has therefore been stopped.

10. The large lenses by Dallmeyer are splendid instruments, and notwithstanding their large size and length of focus, they scarcely require more exposure than some of the lenses in use with the smaller cameras—a great advantage in dull weather. There has not been much difficulty experienced in working plates of the large size of 34″ × 24″ and it is easy to secure the required out-turn daily from the two cameras. On the whole I consider that the plan of photographing complete sheets of these maps has proved satisfactory and saves considerable time and labour, while the expense is little, if at all, greater.

11. The introduction of the large plates and transfers has necessitated a great many new arrangements in the working rooms, but these are now nearly all complete. Full supplies of paper, chemicals and printing materials required for turning out these maps have been received, so that there is no difficulty or delay on that score, and as far as establishment and material are concerned, the work is now fairly started; and were it not for the defects and incompleteness of many of the original drawings, and the consequent necessity for more correction than was at first anticipated, there would be no difficulty in regularly turning out the 12 sheets a day estimated for, or even more, but at present we are only doing 10. The Revenue Survey Office are, however, making every effort to improve the sheets before sending them for reproduction, and I hope that after this month present difficulties will be removed, and the estimated out-turn produced with regularity. It must be remembered that a large new establishment of photographers, draftsmen and printers has had to be found and trained, and it will necessarily take some time for them to become thoroughly efficient. The superintendence of this new work has taken a large share of my time during the year.

12. PROCESSES. *Negatives.*—On further trials with the ferrid-cyanide of lead intensifier described in my last report, it was found that, though undoubtedly a good and valuable method of intensifying, it did not answer so well for large work as the usual bichloride of mercury and hydrosulphate of ammonia, chiefly owing to a tendency for the lines to choke up and the film to disintegrate. It has therefore been abandoned. Mr. J. Mackenzie, the head photographer, has found that old mercury-stained glasses may be quite freed from these stains by soaking them for some hours in the solution of nitrate of lead and ferrid-cyanide of potassium. This is an important discovery, because it enables glasses to be used over and over again without producing fogged images in the parts stained by previous use.

13. When intensifying the large plates for the cadastral maps it has been found useful after fixing the plate to flow it with a solution containing—

Nitrate of silver	...	...	...	...	4 parts,
Citric Acid ...	...	...	...	...	2 „
Water ...	...	...	...	...	100 „

and then re-develope with the usual iron developer. By this means a considerable increase of density in the silver deposit is easily gained, and the subsequent intensification with mercury is facilitated and shortened.

14. *Photo.-transfer.*—Sergeant Harrold has worked out a modification in the method of preparing the photo.-transfer prints which has caused a considerable improvement in the results.

15. The paper is prepared as usual with two coats of gelatine and bichromate of potash. It is then put away for a few days for the gelatine surface to become hard and insoluble, and when required for use it is again coated with the gelatine mixture and then exposed to light, inked and washed in the usual way. In the hot weather it was found that the sensitive paper required to be kept three days before giving the final sensitive coating. In the cold weather six days and upwards are required before the coating becomes sufficiently hard. This time may, however, be shortened by laying the paper face downwards on a board, and allowing the light to act on the back surface for a minute or two. This may be done, either after the print has been obtained from the negative, or just after the preliminary coating has been given to the paper. The action of the light set up by the sunning continues in darkness, and thus hardens the film to the required extent in a very much shorter time than would be necessary in the dark alone. It has also been found that the addition of 2 or 3 grains of either glucose, alum or chrome alum to the ounce of the gelatine and bichromate solution used for the preliminary coating of the paper, hardens the gelatine sufficiently to allow the paper to be used within 2 or 3 days in the cold weather.

16. The advantage of this method is that a base of hard-insoluble gelatine remains on the paper and retains the finest lines, while the fresh and easily soluble final coating preserves the clearness of the ground. It is necessary that the gelatine should be thoroughly hardened otherwise the transfers stick to the zinc plate in transferring, and are difficult to remove; the soft gelatine is also apt to spread over the lines and prevent their transfer.

17. Another advantage is, that warm water is not required for the development of the prints, and the ink is not so liable to become pasty as in the usual way of working. The lines are found to keep crisp and the spaces between them clear and free from scum, thus giving much clearer and sharper transfers.

18. It was hoped to get even better results by inking-in the transfers with a gelatine roller as recommended by Captain Abney for his papyrotype process, and thus avoid the risk of washing off the finer lines, but practically this plan was not found so satisfactory as inking-in in the usual manner with the press.

19. We have as yet not had an opportunity of working this new method throughout the year and so determining the modifications necessary at the different seasons; but next year I hope to test it thoroughly and perfect it.

20. *Pigment Printing.*—348 negatives of convicts were received from the Jail Department during the year, and 9 copies of each were printed off with fair success, part of the tissue used being made in the office. No intimation has been given of any work of the kind being required this year, and I believe the experiment of photographing the convicts is not to be continued.

21. *Photo.-engraving.*—During the year I have made some experiments on a process of photo-engraving similar to that recommended by Messrs. Geymet and Alker in their treatise on "Gravure Heliographique." Gelatine pigment tissue, similar to that used for the Autotype, or pigment-printing process, is sensitised in the usual way, exposed to light under a *reversed* negative, then transferred for development on to a highly polished copper plate, which for convenience in the after processes of electrotyping may be silvered with a solution of nitrate of silver in cyanide of potassium. When the gelatine image has been fully developed a 'grain' is given to it by flowing over the plate an alcoholic solution of tannin about five per cent. This at once removes the water from the gelatine film, and leaves it with a most delicate granulation. This giving the grain is an important point in the process, because without it the ink could not be retained in the hollows of the copper plate when printing. Geymet and others obtain the grain in an entirely artificial manner by impressing the sensitive film with the image of a fine woven tissue, or with engraved ruled or stippled tints, all of which present an unpleasant regularity. The method I have adopted gives a sufficient but almost imperceptible grain, with the effect of a very fine chalk drawing. The solution of tannin has, however, some defects which make it necessary to try to find some other efficient substitute for it.

22. When the gelatine image has thus received the grain, the surface is metallised, or rendered capable of receiving a deposit of copper by the electrotyping process. I have found that the most efficient means of effecting this is to wash the image with a solution of chloride of gold in ether, or in a mixture of alcohol and ether, in the proportion of about one part of chloride of gold to 50 parts of solvent. A short exposure to light completely reduces the gold. The bare portions of the copper plate are cleaned with a little of the silvering solution, and the image is then black-leaded in the usual way with plumbago which has also been treated

with the ethereal solution of chloride of gold. A copper connecting band is soldered to the back of the plate, which is then coated with asphaltum varnish, and when this is dry the plate is ready to be placed in the depositing trough of the electrotyping apparatus. If the gelatine has been rendered thoroughly conducting, the deposit of copper covers the whole surface within a few minutes, but it generally happens that the thicker parts of the image, which represent the deep shadows, swell up in the copper solution and do not readily take the deposit, thus causing irregularities in the deposit which may spoil the result. The deposition is allowed to go on till a plate of sufficient thickness has been obtained. The electrotype is then separated from the matrix in the usual way, and after the edges have been trimmed, and the surface cleaned, the plate is ready for printing in the copper-plate press.

23. One or two excellent plates were obtained by this method, but as success depended upon the working of two processes of which my knowledge was limited, a great many difficulties arose, both in the obtaining of the gelatine matrix and in the electrotyping, which I have not yet been able to overcome, though I hope to do so in the course of next year. The results already obtained show that the process is practical, and if it could be successfully worked would be of value, especially as it has the advantage over collotype that a good plate once obtained, it can be further multiplied by electrotyping; or if protected with a surface of iron, thousands of equally good copies can be taken from it in the ordinary copper-plate press. The plates, moreover, can be put by for future use in the same manner as any other engraved plate.

24. CADASTRAL MAPS OF BENGAL.—The demands of the North-Western Provinces cadastral maps, besides the ordinary office work, have allowed but little progress to be made with the re-production of these maps, and only 137 sheets have been reproduced during the year. No ordinary means will suffice to cope with this immense work, and, as I reported last year, until steps are taken to provide special establishment, plant and accommodation for this purpose, it is hopeless to expect any material advance to be made by this office, however anxious we may be to meet the urgent wants of the Irrigation Department.

Abstract of Work performed in the Surveyor General's Office, Photographic Branch, from 1st October 1876 to 30th September 1877.

	Sections or sheets.	Negative plates.	Carbon prints.	Silver prints.	Photo-transfer prints.	Transfers to zinc or stone.	Number of pulls.	Number of sheets.	Number of complete copies.	REMARKS.
Topographical Maps ...	163	281	...	252	249	100	20,525	20,655	20,655	
Revenue Survey Maps ...	487	535	...	...	522	127	23,460	19,100	19,100	1,430 Anastatic.
District Maps ...	5	20	...	...	12	4	7,914	6,334	2,997	
General Maps ...	55	192	...	46	208	57	10,559	7,829	5,291	620 Anastatic.
City and Cantonment plans	30	62	...	66	144	37	5,442	5,442	1,992	
Miscellaneous Maps, &c.	367	475	...	507	528	180	63,551	82,455	79,783	
Zincographic and Anastatic Transfers ...	...	...	...	...	...	30	...	...	...	
Proofs	...	...	..	...	...	...	5,883	...	...	
Cadastral Survey, Bengal	137	...	...	...	...	137	6,850	6,850	3,500	
Photographs of life convicts	...	...	3,132	...	...	...	...	...	...	
Total ...	1,244	1,565	3,132	871	1,663	672	1,44,184	1,48,665	1,33,318	
Cadastral Survey, North-Western Provinces ...	2,009	4,334	...	...	4,350	2,021	97,000	97,000	65,900	
GRAND TOTAL ..	3,253	5,899	3,132	871	6,013	2,693	2,41,184	2,45,665	1,99,218	

SURVEYOR GENERAL'S OFFICE,
PHOTOGRAPHIC BRANCH;
Calcutta, 15th December 1877.

J. WATERHOUSE, *Captain,*
Asst. Surveyor General.

Statement showing the work done for other Departments.

Names of Departments.	Number of Sections.	Number of Negatives.	Number of complete copies.	Number of silver prints.	Carbon prints of life-convicts.	Price. Rs. As. P.	Remarks.
Foreign Department	2	6	1,980	...	...	182 1 3	
Home Department	...	...	195	...	...	88 8 0	
R. A. C. Department	3	3	165	...	...	20 13 6	
Military Department	20	12	4,312	...	...	1,560 6 3	
Bengal Secretariat	8	11	2,635	...	...	200 3 6	
Government of Bengal, P. W. D. ...	12	41	2,700	...	...	538 13 9	
Government of Punjab, P. W. D. ...	2	29	1,319	...	...	1,122 10 8	
Government, N. W. P., Irrigation Branch	15	15	11,250	...	...	191 9 8	
Quarter Master General	24	39	13,395	...	...	1,165 4 4	
Adjutant General	5	3	525	...	...	35 0 0	
Inspector General, Military Works ...	1	2	250	...	...	40 0 4	
Military Transport Committee ...	48	29	2,194	3	...	265 4 4	
Consulting Engineer to Government of India, Railway Department ...	17	8	1,426	...	...	85 4 5	
Superintendent, Garrison Instruction ...	3	6	246	...	...	23 13 0	
Ordnance Department	2	2	945	...	...	46 8 8	
Consulting Architect to the Government of Bengal	2	2	...	15	...	38 14 0	
Archæological Survey	3	1	5,683	...	...	258 12 6	
Sanitary Commissioner, Central Provinces	2	2	620	...	...	150 15 10	
Superintendent, Forest Surveys ...	...	...	604	...	...	47 4 6	
Executive Engineer, Fort William ...	2	8	32	...	...	38 5 10	
Marine Survey Department ...	18	52	6,350	...	...	1,979 0 11	
Master Attendant	8	38	452	...	...	228 5 3	
Mint Master	...	...	220	...	...	53 2 3	
	...	...	...	34	...	170 0 0	
Gazetteer, N. W. P.	3	2	550	...	...	32 13 8	
Superintendent, Government Printing ...	1	1	49	...	...	10 6 4	
Post Master General	...	...	330	...	...	114 3 6	
Trustees, Indian Museum	1	1	310	...	...	15 12 9	
Meteorological Department	3	3	2,410	...	...	103 4 7	
Talboys Wheeler, Esq.	1	1	20	...	...	3 2 0	
Jail Department, Alipore	...	...	...	...	3,132	783 0 0	348 negatives were received from the Jail Department.
Total ...	206	317	61,172	52	3,132	9,593 13 7	

SURVEYOR GENERAL'S OFFICE
PHOTOGRAPHIC BRANCH;
Calcutta, 15th December 1877.

J. WATERHOUSE, *Captain,*
Assistant Surveyor General.
In charge Photographic Branch.

APPENDIX H.

From CAPTAIN R. V. RIDDELL, R.E., *Assistant Surveyor General, in charge Lithographic Branch, to the* SURVEYOR GENERAL OF INDIA,—*No.* $\frac{269}{L}$, *dated Calcutta, the 4th December 1877.*

I have the honor to submit returns showing the amount of work completed in the Lithographic Office between the 1st October 1876 and the 30th September 1877. From a comparison of these with similar returns of former years, it will be seen that the general out-turn in all the branches, is good.

2. Twenty-one sheets of the Revenue Survey maps (double Royal size) have been drawn on transfer paper and transferred to stone, and five city plans on various sizes. The hills in chalk, on the map of the Province of Sindh and those on a map transcribed for the Foreign Department, are the subjects of that class specially worthy of notice.

3. Good progress has been made in the preparation of District maps transferred from the engraved sheets of the Atlas of India on the scale of 4 miles = 1 inch. These District maps seem to be generally appreciated.

4. Statement B shows the amount and value of work done for other departments; the number of subjects treated amounts to about half that of those of the Survey Department; but the number of impressions or the lithographic press work, is about double that of the regular departmental work, as represented by 1,62,716 pulls for other departments, against 88,159 for the regular work. The cost of this work done for other departments is Rs. 11,888-10-3.

5. The heaviest of these jobs is the Geological Map of India on the scale of 64 miles = 1 inch. This map, which is now about $\frac{2}{3}$rds completed, is in four sheets, each bearing 8 to 10 colors, will probably be completed by March next, and gives promise of being a highly creditable production.

6. Messrs. Jevezy, Niven and Lepage have worked steadily and well throughout the year, and I have great pleasure in bringing their names to your notice. Most of the native draftsmen have also been regular in the performance of their duties.

A.

Statement of Departmental work done by the Lithographic Branch, Surveyor General's Office, between the 1st October 1876 and 30th September 1877, for the Survey Department.

Description of Maps.		Scale of Maps.	Size of each sheet.	No of sheets.	No. of colored Copies.	No. of uncolored Copies.	Total No. of Copies.	Remarks.
NEW MAPS, &c., DRAWN & PRINTED DURING THE YEAR.								
General Maps.								
Map of Territories of his Highness the Khan of Kelat of Baluchistan ...	Chalk hills and corrections done only.	16 miles =1 inch ...	Double Elephant ...	2	...	...	...	Not yet published.
Revenue Survey Maps.								
District Sonthal Pergunnahs, Sheet, No. 12	.....	1 mile=1 inch ...	Double Royal ...	1	...	...	...	Do.
Do. Dinajpoor, Sheet No. 2	.....	„ „ ...	Do. ...	1	...	312	312	
Do. Dinajpoor, Sheets Nos. 3, 4, 5, 8, 9, 11 and 13	.....	„ „ ...	Do. ..	7	...	...	...	Do.
Do. Rungpoor, „ „ 2, 3, 4, 5, 6, 7, 8, 10, 12 and 13 ...	.....	„ „ ...	Do. ...	10	...	...	..	Do.
Do. Beerbhoom, Sheet No. 4	.....	„ „ ...	Do. ...	1	...	...	...	Do.
Do. do. do. 7	.....	„ „ ...	Do. ...	1	...	312	312	
Plans.								
Plan of Calcutta, Northern Section	.....	6 inches=1 mile ...	Double Elephant ..	1	...	...	...	Do.
Do. the Sudder Station of Goalpara	.....	16 „ =1 „ ..	Antiquarian ...	1	...	202	202	
Do. the Station of Nugger Golaghat	.....	8 „ =1 „ ...	Imperial ...	1	...	162	162	
Do. the City of Oudh or Ajoodhia, District Fyzabad	.....	10 „ =1 „ ...	Double Elephant ...	1	..	262	262	
Do. the City of Bahraich	.....	8 „ =1 „ ...	Atlas ...	1	...	...	...	Do.
MAPS TRANSFERRED FROM THE ENGRAVED SHEETS OF THE ATLAS OF INDIA AND FROM STANDARD STONES.								
General Maps.								
Map of India, No. 3	Corrections and additions drawn only.	64 miles =1 inch ...	Double Elephant ...	2	451	307	758	
Do. the Province of Sindh	Chalk hills and sand drawn only.	16 „ =1 „ ...	Do. ...	1	...	...	...	Do.

Do. do. do (without hills)	Corrections and color stones prepared.	" " ...	Do. ...	1	154	102	256				
Do. North-East Frontier, Peshawar to Cabul	Do. ...	4 " =1 " ...	Do. ...	2	210	112	322				
Atlas of India, Quarter Sheet No. 23 N. W.	Color stones prepared	" " ...	½ Sheet Atlas ...	1	...	...	...	Do.			
Do. do. do. do. " 23 S. W.	Do. ...	" " ...	Do. ...	1	102	102	204				
Do. do. do. do. " 34 "	Do. ...	" " ..	Do. ...	1	105	102	207				
Do. do. do. do. " 34 N. W.	Do. ...	" " ...	Do. ...	1	...	...	...	Do.			
Do. do. do do. " 52 S. E.	Do. ...	" " ...	Do. ...	1	215	102	317				
Do. do. do. do. " 52 N. W.	Do. ...	" " ...	Do. ...	1	254	204	458				
Do. do. do. do " 53 N. E.	Do. ..	" " ...	Do. ...	1	204	102	306				
Do. do. do. do. " 72 N. W.	Do. ...	" " ...	Do. ...	1	102	101	203				
Do. do do. do. " 72 S. W.	Do. ...	" " ...	Do. ...	1	208	102	310				
Do. do. do. do. " 93 S. E.	Do. ...	" " ...	Do. ...	1	152	100	252				
Do. do. do. do. " 93 N. E.	Do. ..	" " ...	Do. ...	1	...	...	...	Do.			
Do. do. do. do. " 124 S. E. ... — ...	Do. ...	" " ...	Do. ...	1	211	100	311				
Do. do. do. do. " 130 N. W.	Do. ...	" " ...	Do. ...	1	156	102	258				
DIVISIONAL MAP.											
Map of Presidency Division	Corrections, boundaries, margin lines, &c., drawn.	8 miles = 1 inch ...	Double Elephant ..	1	209	100	309				
DISTRICT MAPS.											
District Chittagong, Sheets Nos. 2 and 3	Chalk hills added ...	4 miles = 1 inch ...	Imperial ...	2	...	203	203				
Do. Sarun	Corrections, boundaries, margin lines, &c., drawn, and color stone prepared.	" " ...	Atlas ...	1	150	100	250				
District Mozufferpoor	Do. ...	" " ...	Do. ...	1	...	...	...	Do.			
Do. Durbhunga	Do. ...	" " ...	Do. ...	1	...		...	Do.			
Do. Monghyr	Do. ...	" " ...	Do. ...	1	186	102	288				
Do. Pooree	Do. ...	" " ...	Do. ...	1	152	100	252				
Do. Burdwan	Do. ...	" " ..	Double Elephant ...	1	157	152	309				
Do. Lucknow	Do. ...	" " ...	Super Royal ...	1	262		364				
Do. Oonao	Do. ...	" " ...	Imperial ...	1	...	...	...	Do.			
Do. Barabunkee	Do. ...	" " ...	Super Royal ...	1	202	102	304				
Do. Fyzabad	Do. ...	" " ...	Do. ...	1	...	306	306				
Do Roy-Barielly	Do. ...	" " ...	Do. ...	1	204	102	306				
Do. Sooltanpoor	Do. ...	" " ...	Do. ...	1	...	...	...	Do.			
MAPS, &c., DRAWN PREVIOUSLY; BUT PRINTED DURING THE PRESENT YEAR.											
DIVISIONAL MAPS.											
Map of Dacca Division	Color stone prepared	8 miles = 1 inch ...	Double Royal ...	1	258	100	358				
Do. Chittagong Division	Do. ...	" " ...	Atlas ...	1	150	100	250				
Carried over ...	.....	.....	.....	64	4,454	4,457	8,911				

Description of Maps.		Scale of maps.	Size of each sheet.	No. of sheets.	No. of colored copies.	No. of uncolored copies.	Total No. of copies.	Remarks.
Brought forward ...	.....	.....	.....	64	4,454	4,457	8,911	
District Maps.								
District Balasore	Color stone prepared	4 miles = 1 inch ...	Atlas ...	1	204	100	304	
Renenue Survey Maps.								
District Southal Pergunnahs, Sheets Nos. 4, 6, 7, 8, 9, 10, 11, 13, 15, and 16	.....	1 mile = 1 inch ...	Double Royal ...	10		3,120	3,120	
Do. Beerbhoom, Sheet Nos. 1, 2, 3, 5, and 6	.....	" " ...	Do. ...	5	...	1,410	1,410	
Do. Dinagepoor, Sheet No. 1	.....	" " ...	Do. ...	1	...	312	312	
REPRINTS.								
General Maps.								
Map of India, No. 1	Color stone prepared	256 miles=1 inch ...	Foolscap ...	1	200	100	300	
Do. do. No. 2	Do.	64 " =1 " ...	Double Royal ...	2	451	205	656	
Do. do. No. 1, without names	.....	.....	Foolscap ...	1	...	204	204	
Do. do. No. 2, showing the progress of the Imperial Survey ...	Color stone prepared	128 miles=1 inch ...	Imperial ...	1	360	...	360	
Map of British Burmah, Pegu Division, Sheet No. 3	.....	4 miles=1 inch ...	Double Elephant ...	1	...	104	104	
Do. do. Sheet No. 4	.....	" " ...	Do. ...	1	...	104	104	
Skeleton map of Punjab and surrounding Countries	.....	32 miles=1 inch ...	Atlas ...	1	...	408	408	
Map of Assam, Sheet No. 5	.....	8 " 1 inch ...	Imperial ...	1	...	25	25	
District Maps.								
District Chittagong (without hills)	.....	4 miles=1 inch ...	Imperial ...	3	...	232	232	
Do. Noakholly	.....	" " ...	Super Royal ...	4	...	202	202	
Do. Bhaugulpore	Color stone prepared	" " ...	Double Royal ...	1	102	...	102	
Do. Bogra	Do.	" " ...	Super Royal ...	1	102	...	102	
Do. Cuttack	Do.	" " ...	Atlas	1	104	...	104	
Do. Maldah	Do.	" " ...	Imperial ...	1	100	...	100	
Do. Jessore	Do.	" " ...	Double Royal ...	1	104	...	104	
Do. Moorshedubad	Do.	" " ...	Imperial ...	1	104	...	104	
Do. Pubna	Do.	" " ...	Super Royal ...	1	102	...	102	
Do. Nuddeah	Do.	" " ...	Atlas ...	1	102	...	102	
Do. Patna	Do.	" " ...	Super Royal ...	1	102	...	102	
Do. Rajshahye	Do.	" " ...	Imperial ...	1	102	...	102	
Do. 24-Perguunahs	Do.	" " ...	Atlas	1	205	....	205	

INDEX MAPS.							
Index to the sheets of Gwalior and Central India Topographical Survey No. 1 Party	Corrections and color, stone prepared ...	.....	½ sheet Super Royal	1	502	102	604
Index to the sheets of Khandeish and Bombay Native States Survey, No. 2 Party	Do.	.....	Foolscap ...	1	502	102	604
Index to the sheets of Ganjam and Orissa, &c., Topographical Survey, No. 3 Party	Do.	.....	½ sheet Double Royal	1	502	102	604
Index to the sheets of North-East Division Central Provinces Topographical Survey, No. 4 Party	Do.	.....	Foolscap ...	1	502	102	604
Index to the sheets of Bhopal and Malwah Topographical Survey, No. 5 Party	Color stone prepared	.....	Foolscap ...	1	502	102	604
Index to the sheets of Khasi, Garo and Naga Hills Topographical Survey, No. 6 Party	Do. ...	.....	½ sheet Double Royal	1	502	102	604
Index to the sheets of Rajpootana Topographical Survey, No. 7 party ...	Do. ...	.....	Do. ...	1	502	102	604
Index to the Indian Atlas, showing the state of the Engraving to 1st October 1876, with three tints	Do. ...	.....	Foolscap ...	1	380	124	504
Index to the sheets of the Atlas of India	Do. ..	.....	Imperial ..	1	204	...	204
Do. do. do.	Do. ...	... ..	Foolscap ...	1	524	...	524
Index to the sheets of District Santhal Pergunnahs	.....	.....	½ sheet Double Royal	1	...	304	304
REVENUE SURVEY MAPS.							
Map of Oudh, sheet No. 40	.....	1 mile =1 inch ...	Double Royal ...	1	...	25	25
Do. do. „ „ 41	.....	„ „ ...	½ sheet Double Elephant	2	...	25	25
Do. do. „ „ 42	.....	„ „ ...	Do. ...	2	...	25	25
PLANS.							
Plan of Simla and Jutog, sheets Nos. 1, 2, 3 and 4, (with hills) ...	.....	8 miles=1 inch ...	Atlas	4	...	200	200
Do. Port Blair, Andaman Islands	.....	4 „ =1 „ ..	Foolscap ...	1	...	25	25
Do. the Town of Calcutta	.....	3 inches=1 mile ...	Super Royal ...	1	202	300	502
Do. Calcutta (old one)	.....	6 „ =1 „ ...	Double Elephant ...	1		22	22
CADASTRAL MAPS	.....	.....	Imperial ...	132	...	6,864	6,864
FORMS	.....	.....	Various sizes ...	50	...	27,545	27,545
MISCELLANEOUS DRAWINGS	.....	.....	.....	15	...	4,223	4,223
TOTAL ...	.....	.....	.....	328	11,722	51,379	63,101

B.

Work done for other Departments.

For what Department.	No. of maps.	No. of sheets.	No. of sheets colored.	No. of sheets uncolored.	No. of copies.	No. of impressions.	Value. Rs. A. P.
Home Department	5	5	3	4	9,908	18,744	571 0 9
Foreign „	10	12	4	12	1,957	6,067	1,381 6 11
Military „	25	25	1	24	2,788	2,820	405 9 5
Department of Revenue, Agriculture, and Commerce	6	6	1	5	765	1,189	128 2 8
Telegraph Department	3	3	.....	3	2,501	2,978	185 15 3
Bengal Secretariat	14	14	2	13	5,784	7,074	711 10 8
Marine Survey Department ...	2	2	1	1	403	539	316 3 0
Sanitary Commissioner	7	7	7	.....	7,680	22,819	912 12 4
For W. W. Hunter Esq., L. L. D., Director General of Statistics ...	5	5	5	.....	11,181	38,280	2,124 4 0
Quarter Master General ...	19	19	.....	19	2,086	2,086	283 5 4
Meteorological Reporter to the Government of India	5	5	3	2	2,536	6,280	498 11 10
Archæological Survey of India ...	26	26	.....	26	19,926	19,926	1,091 15 9
Geological Survey Office ...	6	7	4	3	5,929	18,215	1,335 14 3
Miscellaneous Drawings ...	30	32	3	30	13,708	15,699	1,941 10 1
Total ...	163	168	34	142	87,152	1,62,716	11,888 10 3
Total of Departmental work from Statement A	.....	328	.....	.....	63,101	88,159	.....
Grand Total ...	.....	496	.....	.....	1,50,253	2,50,875	.....

Abstract of Drawing and Printing executed at the Surveyor General's Office, Lithographic Branch, from 1st October 1876 to 30th September 1877.

Subject.	No. of sheets.	No. of copies.	No. of impressions.
District and General Maps, &c.	56	11,789	30,308
Index Maps	11	5,764	11,242
Revenue Survey Sheet Maps, scale 1 mile=1 inch	23	5,541	5,591
Plans	10	1,375	1,884
Cadastral Maps	132	6,864	6,864
Miscellaneous Drawings	15	4,223	4,425
Forms	50	27,545	27,845
	297	.....	.....
Maps drawn, but not printed	31	.....	.....
Total ...	328	63,101	88,159
Work done for other Departments.			
Miscellaneous Maps	66	31,495	82,903
Ditto Plans and Sketches, &c.	83	49,728	61,598
Geological Maps	7	5,929	18,215
	156	.....	.....
Maps drawn, but not printed	12	.....	.....
	168	87,152	1,62,716
Total of Printing in Lithographic Branch ...	496	1,50,253	2,50,875
Type Branch.			
Departmental orders	[illegible]	2,686	3,036
Memoranda and Forms for use of the Department	236	1,19,922	1,66,726
Forms for Topographical and Revenue Surveys	49	75,724	2,18,906
Transfers of Headings, Foot-notes, References, &c., to published Maps ...	3,614	12,493	12,493
	3,946	2,10,825	4,01,161

Statement of expenditure of the Lithographic Branch, Surveyor General's Office, from 1st October 1876 to 30th September 1877.

	Rs.	A.	P.
Permanent Establishment	33,527	0	10
Contingent expenses	4,950	0	5
Total Rupees ...	38,477	1	3

R. V. RIDDELL, *Capt., R.E.,*
Assistant Surveyor General,
In charge, Lithographic Branch.

SURVEYOR GENERAL'S OFFICE,
LITHOGRAPHIC BRANCH,
Calcutta, the 4th December 1877.

APPENDIX I.

List of Revenue Surveys executed from 1845-46 to 1876-77.

Division or Commissionership.	District.	Season of Survey.	Area in square miles as surveyed.	Cost.	Rate per square mile.	Remarks.
	BENGAL.					
Burdwan	Burdwan	1855-57	2,693	71,385	26 8 1	
	Bankoora	1854-56	1,349	38,654	28 10 5	
	Beerbhoom	1848-52	3,114	85,587	27 7 9	
	Midnapore	1872-77	5,828	3,03,417	57 15 2	Includes 192 square miles of District Balasore, and excludes 44 square miles of jungle mehals remaining to complete District Midnapore in 1878.
	Hooghly	1869-73	2,020	1,46,839	72 11 1	
Presidency	24-Pergunnahs	1846-52	2,243	1,12,625	49 7 4	
	Nuddea	1849-55	3,678	1,17,820	32 14 10	
	Jessore	1855-59	3,441	92,151	34 15 9	
	Moorshedabad	1848-53	2,634	73,317	27 13 4	
Rajshahye	Dinagepore	1857-61	4,586	2,02,028	44 0 10	
	Rajshahye	1848-53	3,035	1,04,244	34 5 6	
	Rungpore	1855-59	4,948	1,28,029	25 1 3	
	Bogra	1852-53	818	26,141	31 15 4	
	Pubna	1853-55	1,739	57,013	32 12 6	
	Darjeeling	1861-67	1,234	1,13,810	92 3 8	
	Julpigoree	1864-68	1,879	1,11,478	59 4 9	
	Cooch Behar Native State	1868-70	1,312	83,875	63 14 10	
	Ditto Topographical	1858-60		17,276	13 2 8	
Dacca	Dacca	1857-60	3,421	1,07,373	31 1 6	
	Furreedpore	1858-60	1,417	39,202	27 10 7	
	Backergunge	1850-53	4,439	1,43,975	32 6 11	
	Mymensingh	1850-57	6,454	2,31,415	35 2 1	
	Tipperah	1861-64	2,654	89,105	33 9 2	
	Ditto Hills	1863-64	2,879	43,004	14 14 11	
	Dearah Survey	1863-69 and 1874-77	8,620	4,44,213	51 8 6	The survey extends from Buxar on the west to Burrisal on the east.
Chittagong	Noakholly	1863 65	2,174	72,956	33 8 11	
	Chittagong Hills	1861-66	6,881	1,32,435	19 3 11	
Patna	Patna (*Cadastral*)	1876-77	119	32,102	269 12 3	
	Shahabad	1844-46	4,403	50,858	11 8 9	The Cadastral Survey of the irrigable area in Districts Shahabad and Patna will be completed in 1877-78.
	Ditto (*Cadastral*)	1874-77	935	3,00,626	321 8 5	In these two Districts the Cadastral Survey has been confined to the irrigable area.
	Tirhoot	1846-50	6,114	99,168	16 3 6	
	Sarun	1843-47	6,394	96,986	15 2 8	
	Chumparun					
	Gya (*Cadastral*)	1875-77	456	1,16,299	255 0 8	
Bhagulpore	Monghyr	1836-47	3,593	97,195	27 0 9	
	Bhangulpore	1842-50	7,804	1,14,464	14 10 8	
	Purneah	1844-48	5,712	1,02,587	17 15 4	
	Maidah	1840-50	1,463	32,664	22 5 9	
Chota Nagpore	Hazareebagh	1868-72	7,014	1,59,105	22 10 11	
	Lohardugga Sub-Division Palamow.	1863-69	4,270	2,57,785	60 5 9	
	Manbhoom	1861-67	5,552	2,44,024	43 14 4	
	ASSAM.					
Assam	Goalparah	1849-54	2,556	72,192	28 3 11	
	Ditto	1873-75		1,31,425	51 6 8	
	East Doors	1867-69	1,570	81,759	51 12 6	
	Kamrup	1865-69	3,631	2,14,528	59 1 4	
	Darrang	1871-74	3,418	1,81,803	53 3 0	
	Nowgong	1869-72	3,086	1,88,549	55 3 2	
	Sibsagar	1862-72	2,897	2,03,905	70 6 2	
	Lakhimpur	1866-74	5,318	4,04,602	76 1 3	
	Sylhet	1860-66	4,981	2,13,996	42 15 3	
	Cachar	1864-68	1,722	1,51,245	87 13 1	Includes 425 square miles of reconnoissance (based on triangulation) of the Lushai Hills, south.
	BRITISH BURMAH.					
British Burmah	Akyab	1853-61	10,975	2,32,533	21 3 0	
	Ramree (Island)	1868-70	558	82,605	148 0 7	
	OUDH.					
Lucknow	Lucknow	1861-63	1,417	45,345	32 0 0	
	Bara Banki	1862-64	1,296	43,398	33 7 10	
	Unao	1860-62	1,369	59,220	43 4 1	

Division or Commissionership.	District.	Season of Survey.	Area in square miles as surveyed.	Cost.	Rate per square mile.	Remarks.
	OUDH—*continued.*					
Rae Bareli ...	Rae Bareli	1861-63	1,381	40,322	29 3 2	
	Sultanpur	1862-64	1,575	45,670	28 15 11	
	Partabgarh	1859-62	1,848	82,556	44 10 9	
Fyzabad ...	Fyzabad	1862-65	2,413	1,08,802	45 1 5	
	Gonda	1867-71	3,014	1,85,066	61 6 6	
	Bahraich	1865-70	2,693	1,52,259	56 8 7	
Sitapur ...	Sitapur	1863-65	2,240	85,473	38 2 6	
	Hardoi	1863-66	2,293	88,852	38 10 7	
	Kheri	1865-69	2,992	1,60,532	53 10 5	
	NORTH-WESTERN PROVINCES.					
Rohilkhand ...	Bijnour	1868-71	1,973	1,12,963	57 4 1	
	Moradabad (*Cadastral*) ...	1871-77	2,527	4,54,804	178 16 10	Including Pargana Kashipur of District Tarai.
	Bareilly	1866-72	3,234	1,33,535	46 11 10	
	Bareilly, Tarai and Kumaon ...	1848-54	2,039	1,17,393	57 9 2	
	Rampoor State	1864-66	898	19,860	22 1 10	
Agra ...	Agra (*Cadastral*)	1872-76	2,190	3,50,552	160 1 1	
	Muttra (*Cadastral*) ...	1871-76	1,369	2,53,358	185 1 1	
	Bharatpore Native State ...	1855-58	1,974	92,417	46 13 1	
Allahabad ..	Banda (*Cadastral*) ...	1874-77	1,895	3,17,311	167 7 2	Survey still in progress.
	Hamirpur ... }	1872-76	2,296	2,93,174	127 11 0	
	Ditto Native States ... }		448	26,908	60 1 0	
	Azamgarh (*Cadastral*) ...	1874-76	441	1,22,159	277 0 1	Only Parganas Sikandarpur and Bhadaun.
Benares ...	Gorakhpur	1864-57	490	31,242	63 12 2	
Jhansi ...	Jalaun... ... ... }	1853-60	6,912	1,91,738	27 11 10	
	Jhansi ... ... }					
	Native States ... ... }					
	Lalitpur	1860-62	1,947	48,392	24 13 8	
	CENTRAL PROVINCES.					
Nagpur ...	Nagpur	1857-60	6,111	2,25,713	36 15 0	
	Chanda	1864-75	9,664	4,46,079	46 2 6	
	Bhandara	1858-72	3,933	1,81,729	46 3 3	
Chattisgarh ...	Bilaspur	1872-74	1,945	77,379	39 12 6	
	Raipur	1863-72	9,481	3,05,264	32 3 2	
Jubbulpore ...	Jubbulpore	1854-67	4,801	2,19,017	50 14 9	
	Saugor	1854-64	4,080	1,74,364	42 15 2	
	Damoh	1863-66	2,510	1,02,889	40 15 10	
	Seoni	1865-69	3,936	1,93,336	51 4 5	
Nerbudda ...	Narsingpur	1861-63	1,916	56,961	29 11 8	
	Hosangabad	1862-68	3,415	1,33,850	39 3 1	
	Nimar	1867-73	3,625	1,92,095	52 15 10	
	Chhidwara	1868-72	3,009	1,75,519	58 5 5	
	Betul	1872-74	1,727	1,03,139	59 11 8	
	PUNJAB.					
Delhi ...	Delhi	1872-74	1,285	69,306	53 14 9	
	Gurgaon	1873-76	2,007	1,11,134	55 6 1	
	Patandi Native State(*Cadastral*)	1875-76	53	7,596	143 5 1	
	Karnal	1870-73	2,361	1,32,191	55 15 10	
Hissar	Rohtak	1875-77	1,809	1,08,752	60 1 10	The Survey of District Sirsa is now in hand
	Native States and Jagirs ...	1861-63	3,448	63,664	18 7 6	
	Umballah	1846-48 }	1,965			
		1850-51 }				
	Ludhiana	1847-50	1,550			
	Thanesur	1846-47 }	2,324	1,94,442	12 8 3	
		1848-49 }				
	Ferozepore	1848-51	2,813			
	Cis Sutlej Native States ...	1846-51	6,870			
Jullundur ...	Jullundur	1846-48	1,911	65,205	34 1 11	
	Hoshiarpur	1847-50	2,203	75,132	34 1 8	
	Kangra	1848-51	2,724	92,899	34 1 8	
Amritsar ...	Amritsar	1851-53	2,168	62,798	28 15 5	
	Gurdaspur	1850-52	1,572	67,934	43 3 5	
	Sialkot	1851-53	1,459	48,983	33 9 2	
Lahore ...	Lahore	1851-54	2,971	79,984	26 14 9	
	Gujranwala	1852-55	3,605	83,715	23 3 7	
Rawalpindi ...	Gujrat	1853-54	2,113	45,105	21 5 6	
	Shahpur	1854-55 }	4,028	53,178	13 3 3	
		1857-59 }				
Mooltan ...	Mooltan	1854-58	6,030	1,10,848	18 6 1	
	Jhung	1853-56	5,233	53,361	10 3 2	
	Montgomary	1853-56	5,748	93,762	16 5 0	
	Muzaffargarh	1855-56	2,255	30,759	13 10 3	

Division or Commissionership.	District.	Season of Survey.	Area in square miles as surveyed.	Cost.	Rate per square mile.	Remarks.
	PUNJAB,—*continued.*					
DERAJAT ...	Leia	1855-59	9,452	1,09,661	11 9 7	The survey of the Derajat is still in progress.
	Dera Ismail Khan, DeraGhazee Khan and Bannu.	1855-61	19,226	2,14,252	11 2 4	
	Ditto Ditto ..	1870-77	12,113	5,34,255	44 1 8	
PESHAWUR ...	Peshawar	1863-70	2,467	1,16,250	46 11 6	
	Hazara	1865-69	3,260	2,23,506	68 9 0	
	Bhawulpur Native State ...	1869-75	17,285	4,13,709	23 14 11	
	RAJPUTANA.					
	Ajmere and Mairwara ...	1847-48	2,661	41,623	15 10 3	
	Jawad Nimach Native State ...	1854-56	1,180	45,062	38 3 0	
	SINDH.					
KARACHI ..	Karachi	1855-56 1858-59 1863-64	5,379	1,90,461	18 10 10	
	Sehwan	1863-64	3,624	55,683	15 5 10	
	Jhirruk	1858-59 1863-64	2,952	28,529	9 10 8	
	Shahbunder	1867-70	4,197	79,669	18 15 9	
SHIKARPUR ...	Jacobabad	1858-59	2,009	27,157	13 8 3	
	Shikarpur	1857-58	1,238	35,838	28 15 2	
	Rohri	1856-58	4,360	63,228	14 8 0	
	Larkana	1859-60 1861-62	3,116	67,725	21 11 9	
	Mehar	1861-62	1,948	28,533	14 10 4	
	Khyrpoor Native State ...	1860-61	6,109	45,990	7 8 5	
HYDERABAD ...	Naushahra	1860-63	3,067	41,448	13 8 3	
	Hyderabad	1863-64 1865-66	417	8,985	21 8 9	
	Hala	1862-65	2,558	43,303	16 14 10	
	Mahomed Khan's Tanda ...	1865-68	3,177	86,170	27 1 11	
	Thar Parkar	1862-69	12,729	1,04,587	8 3 6	
	BOMBAY.					
BOMBAY ...	Deccan Districts	1871-77	16,337	6,02,618	36 14 2	The Deccan Survey in 1871-72 was on 8″ scale with exception of 35 square miles. In 1872-73 it was partly on 2″, 4″, and 8″ scale. From 1873-74 only the 2″ scale has been employed Survey still in progress.

D. C. VANRENEN, *Major-General, R.A.,*
Superintendent of Revenue Surveys.

SUPERINTENDENT OF REVENUE SURVEY'S OFFICE,
Calcutta, 5th January 1878.

Nos. 166—167.

Extract from the Proceedings of the Government of India, in the Department of Revenue, Agriculture, and Commerce, dated Calcutta, the 20th March 1878.

[SURVEYS.]

READ—

Letter from the Surveyor General of India, No. 2131, dated the 28th December 1877 (received on the 9th February 1878), submitting the General Report on the working of the Topographical Surveys, and of the Head-Quarter Offices of his Department, for the year 1876-77.

RESOLUTION.

THE number of parties at work during the year was, as in 1875-76, nine; two of these were employed in Mysore. Of these nine parties, however, three had been reduced by the close of 1876-77, two (Nos. 3 and 4) by absorption on the completion of their work, and one by the amalgamation of the two parties employed in Mysore: so that at the end of that year only six remained. The conditions under which work was carried on in the last-named Province were peculiar, and the parties there employed may conveniently, as last year, be excluded from a comparison of the outturn of work for 1876-77 with that of other years. The figures given in Statement C, which purports to show the comparative results of 1875-76 and 1876-77, are vitiated by the exclusion from the statistics of the former year, and the inclusion in those of the latter, of the Mysore work. The correct figures are the following:—

Year.	No. of Parties.	Area of final Topography.	Triangulation in advance.	Cost.
		Square miles.	Square miles.	Rs.
1875-76 ...	7	19,188	19,430	3,86,332
1876-77 ...	7	16,583	12,528	3,60,797

There is thus a decrease of 2,605 square miles in the outturn of final topography as compared with the previous year, of 6,902 square miles in the area of triangulation in advance, and of Rs. 25,535 in the total cost of the seven parties employed. The mileage rate rose from Rs. 20-2-2 in 1875-76 to Rs. 21-12-1 in 1876-77.

2. This apparently unfavourable result is due to a decreased outturn, both under final topography and triangulation in advance, in the work of six out of the seven parties: the seventh, or Rajputana, party alone showing an increase under final topography, as compared with last year, of 444 square miles (4,507 against 4,063), and under triangulation in advance of no less than 3,139 square miles (6,977 against 3,838). This appears from paragraph 147 of the Report to be due to the reduced scale of the survey. Of these six parties, however, two—the Central Provinces and Vizagapatam Agency, and the North-East Division, Central Provinces, parties—completed all the work that remained to be done in their area of survey; they turned out together 4,452·5 square miles of final topography, against 5,579 square miles in the previous year: no triangulation in advance was required; as already noticed, the parties were broken up when their work came to an end. Of the other four parties, the Gwalior and Central India Survey (No. 1) did 1,568 square miles of topography against 2,892 in 1875-76, and no triangulation in advance, of which 2,100 square miles were done last year; the area surveyed is said to have been of an unusually difficult and intricate character: it is not, however, explained why no triangulation in advance was done. The Khandesh and Bombay Native States party (No. 2) did 1,840 square miles of topography and 638 of triangulation, against 1,856 and 3,296 respectively in 1875-76; as 811 square miles of the topography was on the 2-inch scale, against 584 in the previous year, this outturn appears creditable: but the decrease in

triangulation is not explained. No. 5 party (Bhopal and Malwa) turned out 2,968 square miles of topography and 2,867 of triangulation, against 3,266 and 3,830 in 1875-76; the country was difficult, and the outturn, though less than last year, is good. No. 6 party (Khási, Gáro, and Nága Hills) did 1,246 square miles of final topography and 2,046 square miles of triangulation, against 1,532 and 3,966 in 1875-76; the work of this party has always been of an exceptional character, and in the present year its operations in one part of its field were much delayed owing to political considerations; the Governor General in Council is glad to find that Major General Thuillier considers the season's outturn, though considerably less than that of 1875-76, to be fair.

3. The following is a comparison of the work done by the two Mysore parties (now amalgamated into one party) in 1875-76 and 1876-77:—

Year.	Final Topography.	Triangulation in advance.	Cost.
	Square miles.	Square miles.	Rs.
1875-76 ...	None.	9,812	81,356
1876-77 ...	2,325·6	9,591	1,21,161*

During 1875-76 the two parties were working at only half strength, the full estimate for each being Rs. 80,000 a year. In consequence of the famine, the establishments were kept low also during 1876-77, although it had been arranged to commence work at full strength at the beginning of the field-season. The work was carried on under great disadvantages, the area topographically surveyed being necessarily confined to the tracts where supplies were procurable, and much of the triangulation done in 1875-76 remained unutilized for topography. Since the close of the year the majority of the surveyors have been employed on famine duties, and it is estimated by General Thuillier that the one party by which the work will now be carried on will not be able to turn out more than about 2,000 square miles per annum. The Governor General in Council hopes, however, that this estimate will be exceeded, unless it be shown that the quality of the work performed will be thereby deteriorated; the advance triangulation already executed covers 19,403 square miles, while the entire area of the province is only 24,881 square miles; as the party will thus have comparatively little triangulation to do, it will be able to give its full attention to topography.

4. The number of points trigonometrically fixed and of heights determined were 3,643 and 1,880 respectively, against 3,618 and 2,295 in 1875-76; the fair mapping turned out covered 20,237 square miles against 25,360 in the previous year.

5. General Thuillier takes this occasion to review the work done by each survey party from its commencement, and that remaining to be done by the six that are still employed, and to express his appreciation of the officers by whom it has been superintended. These remarks have been read by the Governor General in Council with interest.

6. The progress made with the work of the Compiling and Drawing, the Engraving, the Photographic, and the Lithographic Branches of the Surveyor General's Office during the year appears to have been satisfactory. The Government of India are especially glad to find that the cadastral maps for the North-Western Provinces Revenue Surveys are now well in hand, 1,940 sheets, comprising 65,900 complete copies, having been printed off. All the apparatus, including the large lenses and cameras which were received in July 1877, is reported to be now at work, and the special establishment employed to be growing more efficient. Little progress was, however, made with the Bengal cadastral survey maps, which are on the larger scale of 32 inches to the mile; only 137 sheets were reproduced during the year. Special arrangements are evidently as much required for this as for the North-Western Provinces 16-inch work, and the Governor General in Council trusts that the matter will have the Surveyor General's early attention.

7. This report, the last record of Major General Thuillier's superintendence of that branch of the Survey Department which was in his special charge, fitly includes a retrospect by that officer of the work done during his incumbency as

* NOTE.—This is the figure given for the cost in Statement A, page 39 of the Report; in paragraph 164 (page 34), however, the total cost of No. 8 party is given as Rs. 56,776 instead of Rs. 62,109 as in Statement A. The discrepancy should be explained.

Surveyor General since 1861, and as Superintendent of Revenue Surveys since 1847. The total outturn of work during these periods is as shown below :—

Topographical Surveys since 1860-61, chiefly on the 1-inch and ½-inch scales.

Area surveyed.	Area triangulated.	Cost.	Rate per square mile of topography.
Square miles.	Square miles.	Rs.	Rs. A. P.
291,354	321,097	58,83,134	20 3 0

Revenue Surveys since 1845-46, chiefly on the 4-inch scale.

Area surveyed.	Cost.	Rate per square mile.
Square miles.	Rs.	Rs. A. P.
493,293	1,58,32,766	32 1 6

Cadastral Survey since 1871 on the 16-inch and 32-inch scales.

12,281	22,47,661	183 0 3

making a total area surveyed of 796,928 square miles, or more than half the whole area of India, including the feudatory Native States. Major General Thuillier's eminent services have already been publicly acknowledged, but the Governor General in Council is glad to have this opportunity of again expressing the high appreciation in which they are held by the Government of India, and of congratulating General Thuillier on the splendid outturn of work with which his name will be permanently connected.

ORDER.—Ordered, that a copy of the above Resolution be forwarded to the Surveyor General of India for information.

Ordered also, that a copy be communicated to General Thuillier.

(True extract.)

Officiating Secretary to the Government of India.

1878.

GOVERNMENT OF INDIA.

DEPARTMENT OF REVENUE, AGRICULTURE AND COMMERCE.

SURVEYS.

RESOLUTION.

THE SURVEYOR-GENERAL OF INDIA.

Nos. 166—167.

Dated Calcutta, the 20th March 1878.

SUBJECT.

REVIEW of the General Report of the Surveyor General of India on the working of the Topographical Surveys, and of the Head-Quarter Offices of his Department, for the year 1876-77.

GENERAL REPORT

ON THE

Operations of the Survey of India,

COMPRISING

THE GREAT TRIGONOMETRICAL, THE TOPOGRAPHICAL, AND THE REVENUE SURVEYS UNDER THE GOVERNMENT OF INDIA,

DURING

1877-78.

PREPARED FOR SUBMISSION TO THE GOVERNMENT OF INDIA,

BY

MAJOR-GENERAL J. T. WALKER, C.B., R.E., F.R.S., &c.,
SURVEYOR-GENERAL OF INDIA, &c.,

AND

MAJOR-GENERAL D. C. VANRENEN, R.A.,
DEPUTY SURVEYOR-GENERAL, &c.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING.
1879.

INDIA
SHEWING THE PROGRESS OF THE IMPERIAL SURVEYS
To 1st October 1878.
Scale of English Miles
ARABIAN SEA
BAY OF BENGAL
INDIAN OCEAN
REFERENCE

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GENERAL REPORT

ON THE

Operations of the Survey of India,

FOR SEASON

1877-78.

INTRODUCTORY.

THE Annual Reports of the Survey Operations embrace the period known as the survey year, and not the calendar or the official year. It is usually reckoned from the 1st October, when the cold season is commencing in most parts of India, and the Surveyors are again taking the field, after having completed the mapping, calculations and general records which were connected with the operations of the previous field season. Both the calendar and the official year commence during the incidence of the field season, and thus neither of them embraces the period which is actually covered by a complete round of survey operations, from the commencement of the field work to the conclusion of the calculations and mapping. Thus the survey year has necessarily to start from an epoch of its own.

2. On the 1st October 1877, when the survey year now under review commenced, Major-General Thuillier, C.S.I., R.A., held the posts of Surveyor General and Superintendent of the Topographical Branch of the Department; and he continued to do so until the 31st December, when he resigned those appointments, and his long connection with the survey of India came to an end. The Government of India have recorded their appreciation of his services, in their Resolution* on the Annual Report of the Operations of this Survey for 1876-77, in which full particulars are given of the large areas surveyed under his direction; and they have also publicly notified in the *Gazette of India*† their high sense of the value of his services, and of the zeal and ability which he had brought to bear on his duties, during an unusually long official career. The Secretary of State has also expressed‡ his hearty concurrence with the opinions of the Government of India.

* No. 166, dated 20th March 1878, in the Department of Revenue, Agriculture and Commerce.

† G. G. O. No. 12, dated 12th January 1878, in Department of Revenue, Agriculture and Commerce.

‡ Despatch No. 37, Geographical, dated 18th July 1878.

3. On the 1st January 1878, the three branches of the Survey Department, *viz.*, the Great Trigonometrical, the Topographical, and the Revenue, were amalgamated. Up to that time they had been virtually separate departments, each with its own cadre of officers and establishments of European and Native Surveyors, and its own Superintendent. Originally, when the three departments were first formed—which was at different times—the duties which each had to perform were essentially distinct. The Trigonometrical Survey was required to furnish the basis on which all surveys of interior details were to rest, and the frame-work within which they were to be fitted and connected together. The Topographical and the Revenue Surveys were to furnish the

interior details; the former was to survey—by the method of plane-tabling—the whole country, including Native States and British Territory, with the exception of the richer British districts paying a large revenue; these districts devolved on the latter, and were surveyed on a larger scale, and by a different *modus operandi*, which was better suited for the determination of exact areas, in order to meet the requirements of the Revenue and Settlement Officers. In course of time, however, work which was originally intended to be executed by only one of the three departments had come to be undertaken, to a greater or less extent, by the others. The Great Trigonometrical Survey was approaching completion, and for many years a large proportion of its Surveyors and higher officers had been employed in topographical surveying, on various scales, both the small which are required for preliminary survey and reconnoissance, and the large which are needed for elaborate and detailed survey. The Topographical Department, though originally intended for the execution of the Primary General Survey of India, had similarly to undertake detailed surveys on large, as well as preliminary surveys on small, scales. The Revenue Department which was originally intended for surveying the rich British districts in the plains of India, leaving the delineation of all hilly country and difficult ground generally to the Topographical, had for some years past been largely employed in the topography of hill districts on a trigonometrical basis. Thus the duties of the three Departments had become gradually intermixed, and they were daily becoming more so; so that of very much of the work now in progress it is a matter of indifference to which of the three branches, as originally constituted, the officer deputed to undertake it may belong.

4. There is, of course, much in common between the operations in the three branches, so that an intelligent Surveyor, who is master of the work in his own branch, can readily learn how to perform most of the work in the other branches. But so long as three separate Departments, separately administered, existed, the transfer of a Surveyor from one to the other, though often very desirable in the interests of the public service, was attended with so many difficulties that it was scarcely ever carried out. Thus a survey party in one branch might be sent, for the first time, to perform duties usually devolving on one of the other branches; but it would have to learn its new duties unaided, otherwise than by being furnished with copies of the instructions issued for the guidance of the other branch, and it would be wholly unassisted in the performance of its new duties by the Surveyors belonging to that branch.

5. The time had obviously arrived for remodelling the Survey Department, and amalgamating it, by combining the three separate cadres of the superior officers—the Deputy and Assistant Superintendents—into a single cadre, and the three separate cadres of the subordinate officers—the so-called Surveyors and Assistant Surveyors—into a single cadre.

6. But to effect a fusion of the three branches of the Department into one, in such a manner as to satisfy every individual affected, and place every one in exactly as favourable a position and with as good prospects of promotion after, as before, the amalgamation, was obviously impossible, without a considerable increase of expenditure: and the position was rendered all the more difficult, because the Government had determined to make a considerable saving of expenditure, by reductions in the numbers of officers and Surveyors from the numbers sanctioned in the latest departmental re-organizations, of which the most important had been introduced only so lately as in 1874. This determination made amalgamation all the more necessary, not merely in the interests of the public service, for the reasons already stated, but in the general interests of the members of the Department. For it had been seriously proposed that, as each survey which was then in progress became completed, the individuals composing the survey party should be got rid of, instead of being transferred to undertake new surveys in other localities. Such a measure would be liable to fall so unevenly on the Department, greatly injuring some individuals, and leaving others wholly unaffected, or possibly even benefited in the long run, that it would be grievously unfair and objectionable. Whereas if the Department were first amalgamated, any reductions which the Government might wish to make could afterwards be adjusted to fall more evenly on the whole

body of officers and Surveyors, giving a diminished loaf all round, but leaving no individual without bread.

7. The amalgamation was arranged on a strict calculation of the seniority of each officer, taken on the mean of his total effective service (excluding any time which he might have served as a subordinate, or as a probationer), and of his service in the grade in which he stood on the 1st January 1878. To have made the date of promotion to his grade the basis of the position of each officer in the new cadre, would have been more in accordance with the *quasi*-military organization of the Department. But there had been inequalities in the rates of promotion in the different cadres; and this was sought to be mitigated, as much as might be, by taking the total length of effective departmental service into consideration, as well as existing departmental rank. To have ignored rank altogether, and arranged the officers in accordance with the dates when they were first posted to the Department, would have been objectionable for many reasons, and, though thought of, was set aside as undesirable.

8. The Amalgamated Cadres of Officers and Surveyors are as follow :—

1 Surveyor General and Superintendent of the Trigonometrical and Topographical Branches.
1 Deputy Surveyor General and Superintendent of the Revenue Branch.

4	Deputy Superintendents,	1st	grade.
10	„ „	2nd	„
12	„ „	3rd	„
11	Assistant Superintendents,	1st	„
11	„ „	2nd	„
12	„ „	3rd	„

9	Surveyors,	1st	grade.
12	„	2nd	„
16	„	3rd	„
22	„	4th	„
23	Assistant Surveyors,	1st	grade.
25	„ „	2nd	„
27	„ „	3rd	„
29	„ „	4th	„

9. The designation of 'The Survey of India' has been given to the Amalgamated Department, and the former separate departmental designations have been abolished. In sanctioning this change, the Government of India were pleased to direct that "the Department will henceforth be one body, and its officers available for work of any description that may be required of them."

10. The well-known and time-honoured office of Superintendent of the Great Trigonometrical Survey has been abolished, and its duties, together with those of the administration of the Topographical Surveys, have, for the present, been merged with the duties of the Surveyor General, the Deputy Surveyor General administering the Revenue Surveys.

11. The number of officers in each of the executive grades has been reduced. The several appointments which the department has lost in the recent amalgamation, as compared with the re-organization of 1874, are shewn in the margin.

1 Superintendent, Great Trigonometrical Survey.
1 Joint Superintendent, Revenue Survey.
2 Deputy Superintendents, 1st grade.
4 „ „ 3rd „
1 Assistant Superintendent, 1st „
1 „ „ 2nd „
3 Assistants Surveyors General, formerly in addition to, but now included in, the establishment of Deputy and Assistant Superintendents.
4 Surveyors, 4th grade.
1 Assistant Surveyor, 1st Grade.
3 Assistant Surveyors, 3rd „

This has caused many hopes and expectations of promotion, which had been based on the previous re-organization, to be disappointed, and is a matter to be regretted, though it has been largely in the interests of the Government, from a pecuniary point of view. I submit, however, that some compensation should be given, as soon as practicable, in the form of personal allowances, to the officers who have been most injuriously affected. In consequence of the pressure on the finances of Government, which has been caused, first, by the famine in the Madras Presidency and now by the war in Afghanistan, I have felt that the question of compensation could not with propriety be brought forward at any time since the amalgamation. It is, however, not a matter to be lost sight of; for, even in the pecuniary interests of the public service, it is desirable that public servants should have no valid grievances nor reasonable grounds of complaint. I trust, therefore, that a suitable opportunity for bringing forward the cases of individuals who have materially suffered by the amal-

gamation and the reductions, may soon occur, and that the Government will then be pleased to take all such cases into favourable consideration.

12. A complete fusion of the duties of the three hitherto separate branches of the Survey Department could not, of course, be affected *pari passu* with the amalgamation of the *personnel* of the department. This must be a matter of time and opportunity. Meanwhile several officers and Surveyors will of necessity have to be employed on the same duties as before the amalgamation; but at no very distant date the fusion should be thorough and complete. Its merely partial attainment hitherto is illustrated by the present Annual Report, the first for the Amalgamated Department. In framing this report, it has not been found convenient to group together all the operations of the same nature which have been done in the course of the year; the whole of the operations in the Revenue Branch, whether topographical, mouzawar or cadastral, have been grouped together separately, and are separately reported on by the Superintendent of that Branch, Major-General Vanrenen. Thus the portion of this Report which recounts the operations of the survey parties and offices, is divided into two parts: the first embracing the operations in the Trigonometrical and Topographical Branches and Offices, including what have long been known as the Surveyor General's Offices in Calcutta; while the second embraces the operations in the Revenue Branch and in the Revenue Survey Office at Calcutta.

13. It is, however, desirable that the whole of the operations should now be presented collectively in one view, grouped with reference to their nature and scope, and irrespectively of the branch of the department in which they were executed. This is done in the following table:—

Nature and Locale of Operation.	Name of Executive Officer.	Designation of Survey Party hitherto.	Remarks.
Triangulation.			
Madras	Lt.-Col. B. R. Branfill ...	Madras Party ...	Principal triangulation.
Tavoy	Capt. J. Hill, R.E. ...	Eastern Frontier Party	Ditto.
Eastern Sind	Capt. M. W. Rogers, R.E. ...	Bombay Party ...	Principal triangulation suspended. Secondary triangulation and geographical reconnoissance towards Quetta undertaken instead.
Assam	Lieut. H. J. Harman, R.E. ...	Assam triangulation.	Secondary triangulation and geographical reconnoissance.
Burmah	Mr. W. G. Beverley ...	Burmah triangulation.	Secondary chains resting on Eastern Frontier series.
Topography.			
Central India	Capt. C. Strahan, R.E. ...	No. 1 Topographical Survey.	Survey on 1-inch = 1 mile scale, for publication on same scale.
Khandesh	Mr. H. Horst ...	No. 2 Topographical Survey.	Survey on 1 and 2-inch scales, for publication on 1 inch scale.
Malwa	Capt. J. R. Wilmer, S.C. ...	No. 5 Topographical Survey.	Survey and publication on 1-inch scale.
Khasi and Gharo Hills ...	Major W. F. Badgley, S.C ...	No. 6 Topographical Survey.	Various scales, 1 inch to ¼-inch.
Rajputana and Simla ...	Lt.-Col. G. C. Depree, S.C. ...	No. 7 Topographical Survey.	Scales of 1 inch and 6 inches.
Guzerat	Major T. T. Carter, R.E. ...	Guzerat Trigonometrical Survey.	2-inches, for publication on full and half scales.
Kattywar	Major A. Pullan, S.C. ...	Kattywar Trigonometrical Survey.	2-inches, for publication on 1 inch scale.
Kumaun and Gurhwal ...	Mr. E. C. Ryall ...	Kumaun and Gurhwal Trigonometrical Survey.	½-inch and smaller scales in higher Himalayas.
Mysore	Major H. R. Thuillier, R.E. ...	Mysore Topographical Survey.	Survey and publication on 1 inch scale.
North Deccan	Capt. E. W. Samuells, S.C. ...	10th Revenue Survey.	2-inches, for publication on 1-inch scale.
South „	Major H. C. B. Tanner, S.C. ...	11th „ „	2-inches, for publication on 1 inch scale.
N. W.-Provinces ...	Major W. H. Wilkins, S.C. ...	3rd „ „	2-inches, for publication on full and half scales.

Nature and Locale of Operation.	Name of Executive Officer.	Designation of Survey Party hitherto.	Remarks.
Mouzawar or Village Survey.			
Trans-Indus and Rawal-Pindi.	Col. H. C. Johnstone, C.B., S.C.	1st Revenue Survey.	On scales of 4 and 16 inches.
Sirsa	Major D. Macdonald, S.C. ...	2nd „ „	On 4-inch scale.
Budaon	Capt. W. Barron, S.C. ...	4th „ „	Ditto.
Cadastral Survey.			
Banda	Col. F. C. Anderson, S.C. ...	5th Revenue Survey.	16-inch scale, interspersed with village survey on 4-inch scale.
Jaunpur	Mr. E. T. S. Johnson ...	6th „ „	16-inch scale, interspersed with village survey on 4-inch scale.
Khurdah Estate ...	Mr. R. B. Smart ...	7th „ „	32 inch scale.
Soane Irrigation Tracts ...	Major J. Sconce, S.C. ...	8th „ „	Ditto.
Cuttack Irrigation „ ...	Capt. D. C. Andrew, S.C. ...	9th „ „	Ditto.
Barkagarh and Chota Nagpore.	Capt. J. E. Sandeman, S.C. ...	(Half Party) ...	Ditto.
Miscellaneous.			
Kamrup	Mr. W. H. Patterson ...	Lakhiraj Survey ...	Surveys of lakhiraj holdings on scale of 8 inches = 1 mile.
Astronomical.			
Electro-telegraphic determination of longitude.	Major W. M. Campbell, R.E. ...	No. 1, Extra, Trigonometrical.	In abeyance, because of absence of both officers on leave.
	Capt. W. J. Heaviside, R.E. ...	No. 2, Extra, Trigonometrical.	
Tidal and Leveling.			
Bombay and Madras ...	Capt. A.W. Baird, R.E. ...	Tidal and Leveling.	

14. The present seems to be a fitting opportunity for placing on record a memorandum regarding the nature and cost of the principal survey operations conducted by this Department, which it was necessary for me to draw up, during the course of the present year, to assist in the formation of correct views regarding the cost of professional survey work, of various kinds, as now being executed by this Department, and correct estimates of the probable cost of any analogous operations which we may hereafter be called upon to perform. Opinions had been expressed by the Board of Revenue of the Lower Provinces, and endorsed by the Bengal Government, to the effect that the operations of this Department, at least in Bengal, had not, as a rule, answered the expectations which had been formed of them, nor fulfilled the object of facilitating the settlement proceedings as much as they might have done; that they had been exceedingly costly, and that the work which the Government of Bengal (in the Revenue Department) wished to have done, might be done by a non-professional agency, at a much smaller cost, with sufficient accuracy for the purposes of the settlement. In order to ascertain what weight should be attached to the objections of the Board of Revenue, it was necessary for me, in the first instance, to draw up the following statement, to serve as a criterion by which the operations might be rightly judged.

The work of the Professional Survey Department, under the Government of India, may be broadly divided into three classes,—excluding the principle triangulation, the geodetic operations, the tidal investigations, and much miscellaneous work of a scientific nature which the Department is called upon from time to time to perform. The three classes of ordinary survey are—1st, the General Survey, on the standard scale of 1 inch to the mile, of the hilly, more rugged and poorer portions of the British Districts, and of the whole of the Native States. 2ndly, the Mouzawar or Village Survey, on the scale of 4 inches to the mile, of the richer portions of the British Districts, as an aid to the operations of the Settlement Surveys. 3rdly, the Cadastral or Field Survey, on the scale of 16 inches to the mile, of British villages, in supersession of the field measurements of the Settlement Surveys. Other classes of survey, and on other scales, have been and are being undertaken, but not to anything like the same extent as

those now specified; they do not furnish as good a criterion of the cost of the work of the Professional Survey, and therefore they need not be here noticed.

The nature and cost of each of these three classes of operations will therefore be indicated. The facts and figures will be taken from the published annual reports of the Topographical Surveys under the Surveyor General, and of the Revenue Surveys under their respective Superintendents, for the years 1867-68 to 1876-77: and, in order that the results for different years may be strictly comparable, so as to give a fair average, all mixed work executed by the same party on different scales, for which the requisite data are not forthcoming to show the cost of the work on each scale separately, and which might thus lead to erroneous conclusions, will be omitted.

I.—The Topographical Survey, on the 1-inch scale.

This survey is constructed by the method of plane tabling, on a trigonometrical basis, in such a manner as to exhibit the positions of towns and villages, the courses of rivers, the general features of the ground, and as much detail as the scale will admit of, with a sufficient degree of accuracy for the requirements of a general topographical map on the 1 inch scale. The Surveyor goes over the ground with his plane table, which he sets up at a sufficient number of points to enable him to 'cut in' all the most prominent objects and to sketch the general features of the country; the number of these points, called 'plane table stations,' will vary with the nature of the ground, being few where it is flat and open, and numerous where it is hilly and rugged. In all cases the plane tabler actually goes over only a comparatively small portion of the ground, the greater portion being sketched in from his stations. He surveys no village boundaries, but only the principal boundaries, *viz.*, those of the British Districts and the Native States and their sub-divisions, when they have been demarcated before-hand.

The plane tabling executed during the ten years in question was performed at the average speed of 55·8 square miles *per mensem* for each Surveyor who was actually employed in that portion of the operations; the time occupied in marching, twice annually, between the recess quarters and the district under survey, is excluded from this calculation. The average monthly out-turn *per* plane tabler ranges from 35 square miles in difficult ground to 116 square miles in easy ground. Thus, excluding Sundays, the daily out-turn of work executed by each plane-tabler was on an average slightly in excess of 2 square miles, ranging from 1⅓ to 4¼.

The total cost of the surveys during the same period—including triangulation, calculations, mapping and supervision by the Executive Officer—averaged Rs. 21-12 *per* square mile, ranging between mean annual maximum and minimum rates, for all the survey parties, of Rs. 28 and Rs. 18, and between a maximum rate of Rs. 41 and a minimum of Rs. 11 for individual parties, in single years.

The agency employed in the operations was mixed European and Native, the former element slightly predominating, and taking the greater share of the plane tabling in hill districts and difficult ground, and the lesser share in the plains.

II.—The Village or Mouzawar Survey, on the 4-inch scale.

This survey is also constructed by the method of plane tabling, but on a basis formed by carrying traverses (with theodolites and chains) round the boundaries of villages, instead of on a triangulated basis. The usual details of the ground are laid down by the plane-tabler, who is also required to delineate the limits of the lands which happen to be respectively cultivated, fallow, or waste, at the time of survey. For this reason, and because of the larger scale of the survey, the plane-tabler has to go over the ground very much more closely than he has to in the 1-inch Topographical Survey, and his rate of progress is proportionately slower.

The requisite data are not at present available to show the speed of survey as accurately as in the preceding instance; but it may be taken to be on an average about 14 square miles *per mensem*, during the time that the plane-tabler is actually on the ground. Deducting Sundays, this gives an average rate of (say) half a square mile *per diem*.

The total cost of the survey—including traversing, calculations, mapping and supervision—during the 10 years in question, averaged Rs. 53 *per* square mile, ranging between mean annual maximum and minimum rates of Rs. 59 and Rs. 47 for all the survey parties, and between a maximum rate of Rs. 102 and a minimum of Rs. 39 for individual parties, in single years.

The agency employed in the operations was mixed European and Native, in the proportion of 1 European Surveyor to about 4 Native Surveyors. As a rule, the whole of the plane tabling was done by the Natives, the Europeans being employed on the traverses and calculations, and in supervising and checking the Natives.

III.—The Cadastral Survey, on the 16-inch scale.

This survey is also constructed on the basis of the traversed boundaries of the villages;—the whole of the interior details of the fields are, however, obtained, not by plane tabling, as in

the previous instances, but by systematic chaining, which is duly recorded in field books, and is thus available for future reference whenever it may be wanted.

The agency employed was mixed European and Native, in the proportion of about 1 European Surveyor to 4 Native Surveyors, *plus* 17 Measuring Amins. The Europeans were wholly employed on the traverses and calculations, and in supervising the Natives and testing their work by running check lines over it.

The rate of progress was very variable, depending mainly on the average size of the fields which had to be measured. In certain districts this was one acre, in others two acres. The average out-turn may be taken as about 20 acres *per* working day, for each Measuring Amin, at which rate a single individual would complete a square mile in 32 working days.

The work is comparatively new to the Department, having been commenced in the year 1871-72. Thus only 6 years' rates are available, and as they include the early years of trial and training, of determining the *modus operandi* best suited to the requirements of the Settlement Officers, and of teaching a large number of additional hands who had to be entertained for the purpose, they do not indicate the cost of the work as exactly as do the rates which have been given for the Topographical and the Village Surveys. Still, however, they may be accepted as furnishing a fairly reliable criterion of the cost of this sort of work. They are as follow: the general average of the 6 years is Rs. 165 *per* square mile; the mean annual average of the several parties ranges from a maximum of Rs. 205 to a minimum of Rs. 129; and the rate for individual parties ranges from Rs. 318 to Rs. 77, in single years.

It may be observed that the general average rate of Rs. 165 *per* square mile is almost identical with the average rate—Rs. 162—of the Cadastral Surveys, on the same scale, in the Madras Presidency during the nine years, 1864 to 1872.

See paragraph 26 of Colonel Priestly's letter No. 1333-40, dated 12th June 1873, to Secretary, Madras Government, Revenue Department.

The relative intrinsic value of the three classes of Survey.

Thus we see that the average rates of the three classes of survey *per* square mile have been Rs. 22 for the Topographical 1-inch, Rs. 53 for the Village or Mouzawar 4-inch, and Rs. 165 for the Cadastral 16-inch, Survey. The three surveys have one point in common, in that each rests on an accurate scientific basis, which may in all cases be accepted as practically perfect. The Topographical basis, being a net-work of triangulation which is independent of any chaining, is rather more accurate than the basis for the other two, which is furnished by the village boundary survey. But there all superiority of the Topographical ends. For the practical value of a map to the general public depends more on the accuracy and minuteness of the interior details than on the exactitude of the points upon which those details are fitted. Now the points may be plotted on the map within $\frac{1}{100}$th of an inch of their true positions, but the details are liable to errors of fully $\frac{1}{10}$th of an inch; in other words, the errors of plotting on the maps correspond to distances on the ground of fully 106 feet for the 1-inch scale, 27 feet for the 4-inch, and 7 feet for the 16-inch.

These figures represent the superiority of the Cadastral over the Village Survey, and of the latter over the Topographical, which is due to increase of scale; but they do not represent the full superiority of the Cadastral over the two other surveys. For in the Cadastral all the details of the interior field measurements, in addition to those of the exterior village boundary, are recorded in field books, and are available for future reference whenever they may be wanted; they may thus be employed hereafter for the purpose of constructing maps on a larger scale than the adopted one of 16 inches to the mile, whenever circumstances arising either from an increase in the value of the land, or from subsequent divisions of property, or from any other cause, may render such a measure desirable; they are also of great value for the purpose of deciding disputes which may hereafter arise regarding the boundaries of private properties, as occur when divisions between fields have been ploughed up, or the land-marks have been removed, either inadvertently or fraudulently. Moreover, the *modus operandi* for obtaining the interior detail, by carefully systematized chain measurements, made by one man and plotted independently by another, is vastly more accurate than that of the method of plane tabling, by which all the interior details of the Village and the Topographical Surveys are usually laid down by one and the same individual.

In ordinary plane tabling no numerical record is kept of angles and distances, and the work is therefore unsusceptible of being reproduced on a larger scale. The details are plotted on the spot, and there is no way of testing their accuracy otherwise than by an independent re-survey. Errors are liable to accumulate in the work to as much as, or even more than, $\frac{1}{10}$th of an inch on the map, which represents 528 feet on the ground on the 1-inch scale, and 132 feet on the 4-inch scale; this happens more particularly when the fixed points, on which the survey of the details is based, are few and far off, or when they are hidden by intermediate objects. These, and even larger errors, may altogether escape observation. But they may be discovered by the Surveyor himself; and then, if he is a painstaking man and conscientious, he will go over his work again, probably at a loss of several hours, if not days; if he is unscrupulous, or nervously afraid that his out-turn of work will be deemed too small and

himself found fault with, he will force in his work somehow, and very possibly its errors may not be found out until long after the completion of the survey. A skilful and conscientious Surveyor may fill in the details of the ground by plane tabling, as accurately as can be done, for a map on the same scale, by any other process of surveying whatever. But when the details are very numerous and minute, plane tabling will generally be found in India to be much more expensive than chaining; because, then, men of superior skill, who must be much more highly paid than mere Measuring Ameens, are required to perform it properly; while for the purpose of recording the boundaries of properties, it is not nearly so valuable, as it gives no numerical record of the measurements.

For the purposes of a cheap First Survey of India, giving the general features of the country and all the most prominent objects on the ground, with a fair degree of accuracy—say, with errors rarely exceeding $\frac{1}{10}$th of a mile—the Topographical Survey on the 1-inch scale is admirably constituted. It has been frequently described by my predecessor, General Thuillier—under whose administration an area of not less than 250,000 square miles was thus treated—as the First Survey of India. As a basis for the engraved Atlas of India, on the $\frac{1}{4}$-inch scale, nothing could be more admirable.

The Village or Monzawar 4-inch Survey may ordinarily be taken to be superior—as regards the fullness and accuracy of interior details—to the Topographical Survey in the proportion of their respective scales. The 4-inch scale, however, is too small to permit of the boundaries of properties being laid down with precision, more particularly by the method of plane tabling. The principal value of the Mouzawar Survey lies in the circumstance that the village boundaries are all carefully traversed, and that all the measurements of the angles are duly recorded and preserved; thus data are forthcoming for calculating the area of each village with great accuracy, and the areas thus determined serve as a check on those obtained by the Settlement Officers, from the measurements of the fields by their Ameens. Moreover, the work is of permanent value, and whenever it has been connected with permanent marks on the ground, it may be accepted as the basis of a new survey, to be constructed hereafter on a larger scale, if the growing wealth of the country renders such a measure desirable.

Now the 16-inch Cadastral Survey costs about three times as much as the 4-inch Mouzawar, and seven and half times as much as the 1-inch Topographical; but, for the amount of information which it gives, it appears to be the cheapest of all. Assuming the extent of interior detail to be roughly proportional to the area surveyable by one man (in a working day) under each system, the intrinsic value of the 16-inch survey would be sixteen times that of the 4-inch and sixty-four times that of the 1-inch. That the relative cost does not follow the same proportions is due to the circumstance that the proportion of Native to European agency differs so considerably in the three surveys, being about four times as great in the 4-inch, and twenty-one times as great in the 16-inch, as it is in the 1-inch survey. Moreover, the Cadastral Survey should not cause an increase of expenditure to the Government to anything like the extent of its excess over the cost of the Mouzawar Survey, because the field measurements are mostly made by men who would otherwise be employed in taking measurements and constructing maps for the Settlement Officers, and would then be paid for by the Settlement instead of by the Survey Department.

In order to complete the subject, it should be added that the preceding rates of expenditure include the whole cost of the actual survey work, but do not include the cost of publishing the maps. All map publication has been usually done in the Surveyor General's Offices at the Presidency. It has hitherto been almost entirely restricted to the 1-inch maps of the Topographical and the Mouzawar Surveys; the village maps of the latter, on the 4-inch scale, have not, as a rule, been published, but a copy of each map has been made by hand for the use of the District Officers. The cost of publication to this extent would probably not increase the survey rates by more than a few annas *per* square mile, and so it has not been added to them. But the cost of publishing the maps of the Cadastral Survey is a much more serious matter, as they are so numerous. Assuming the area of a district to be of such a magnitude as to fill a map, on the 1-inch scale, of the same size as the standard maps on that scale, then a Cadastral Survey on the 16-inch scale will require 256 maps, and one on the 32-inch scale will require 1,024 maps, of the same size, to indicate all the details of the ground. Thus the publication of the cadastral maps was far beyond the capabilities of the Surveyor General's Offices at Calcutta, as originally designed to meet the requirements of the Topographical and the Mouzawar Surveys only. A special branch was therefore added to the Photozincographic Office, at a sanctioned cost of Rs. 30,000 *per annum*, to meet the requirements of the Cadastral Surveys in the North-West Provinces, all which are on the 16-inch scale. In Bengal the fields are so much smaller than in the North-West Provinces, that it has been necessary to increase the scale of the Cadastral Survey, in some districts, to that of 32 inches; thus these districts require four times as many maps for a given area as do those in the North-West Provinces. This demand can only be met with the assistance of the lithographic tradesmen in Calcutta. Copies of the maps are drawn in lithographic ink, on transfer paper, ready for transfer to stone; these are handed over to the lithographers, by whom they are printed at the rate of Rs. 4 per 50 copies of each sheet, the paper being supplied by this Office. This increases the cost of the 32-inch Cadastral Survey by about Rs. 20 the square mile, or half an anna the acre. The drawing on transfer paper costs about as much more, when done by contract, as is usually necessary because of the press of

work. The photozincographed cadastral maps cost a little more than the lithographed, but they have the advantage of being exact *fac similes* of the originals, and they are, of the two, much the less liable to error.

The average cost-rates given above have been derived,—for the Topographical Surveys, from operations throughout India; for the Mouzawar Surveys, from operations in the Bengal Presidency; and for the Cadastral Surveys, from operations in the North-West Provinces.

15. There have, however, been Cadastral Surveys in Bengal Proper also. They were commenced some years after those in the North-West Provinces. Their cost has been strongly objected to by the Board of Revenue of the Lower Provinces. It appears to be an axiom with the Board that any survey of fields or properties, which may be made with a view to aid the operations for the settlement of the revenue, is not needed to subserve any other requirements, and therefore that it should not cost a larger sum than the increase of income to be derived, in the course of three or four years, from the enhanced assessment of revenue made at the time of the settlement which immediately follows the survey.

16. The Cadastral Surveys in different parts of Bengal were undertaken at the request of different departments of the administration. Of late years extensive tracts of country have been brought under irrigation, by the Soane and other canals; and it was thus a matter of importance to have a correct survey made of all the fields which had been, or were liable to be, irrigated from the canals, with a view to the correct assessment of the taxation for water supply. Such surveys were commenced by officers of the Department of Public Works; but they were soon afterwards handed over to this Department to execute, on the understanding that they would be paid for out of the funds provided for the construction of the canals, and thus that they would not form a charge against the Survey Budget. Other cadastral surveys were undertaken at the request of the Civil Administration, in connection with the settlement operations, as in the North-Western Provinces. Now, in Bengal generally, it has been found that the fields are so small that the scale of survey has to be increased from 16 inches to the mile, which had sufficed for the North-Western Provinces, to 32 inches. This has necessarily increased the cost very materially, raising it much above 4 annas the acre, which is the average rate for the 16-inch survey, with fields of an average area not less than one acre. Thus it happens that in an area of 1,811 square miles, which has been cadastrally surveyed on the larger scale in the Soane Irrigation tracts, the average size of the fields is 0·29, or say $\frac{2}{7}$ths, of an acre, and the average cost of the survey—inclusive of all charges, with the exception of those for the publication of the maps—has been 8 annas the acre. The increase of cost is only what was to have been expected, considering the large increase in the proportion of the number of fields to be surveyed in any given area. But the cost being only a fraction of the increase of revenue annually derivable from the canals, could not well be objected to; and it has been accepted without demur by the Department of Public Works, for which the survey was executed, and by which the entire cost of publishing the maps has also been defrayed.

17. On the other hand, the Cadastral Surveys in Bengal have been strongly objected to by the Board of Revenue of the Lower Provinces, on the ground of their cost. The survey of the Government Estate of Khorda in the Province of Orissa, being the one which has cost most, and to which most exception has been taken, may be here noticed. It was undertaken—at the suggestion of the Lieutenant-Governor of Bengal* after a personal visit to the Province—apparently with a view partly to future operations of the Canal Department, but chiefly to the immediate requirements of the Revenue Settlement. It was commenced in 1875. The average cost promises to be about 12 annas an acre. The average area of the fields at first was about $\frac{1}{7}$th of an acre, or only half that of the fields in the Soane Irrigation tracts; subsequently larger fields were met with, and now the general average size is about the same for the two surveys.

* Letter No. 2445, dated 5th December 1874, from Bengal Secretariat to the Government of India.

18. The rate of progress was at first very slow, and the rate of cost proportionately higher, reaching 16 annas the acre, the highest yet met with in the cadastral operations of this survey. It happens, however, that the survey was commenced, and has hitherto been carried out, by the very Officer who had been previously employed in making a Cadastral Survey of the District of Hamirpur, in the North-West Provinces, the rate of which was only about 3 annas the acre, the lowest as yet reached in our cadastral operations. Obviously, therefore, there were great differences in the conditions under which the operations were carried on in the different localities, for the one survey to be costing four times as much as the other. These may be briefly pointed out here, to assist in arriving at correct conclusions hereafter, as to whether the conditions met with in any District, which is about to be surveyed for settlement operations, are such as to make it worth while to have a Cadastral Survey.

19. *First*, the number of fields in a given area has been increased nearly six-fold, the average area of each field being only 0·29 of an acre in Khorda, whereas it was 1·69 in Hamirpur. This is the primary and most important cause of all; and it may be accepted as accounting for an increase of rate from 3 annas, that of Hamirpur, to 8 annas, that of the Soane Survey, with fields of the same average size as in Khorda. *Secondly*, the further excess from 8 to 12 annas—which last may be taken as a fairly probable estimate of what the expense will be if the survey is completed cadastrally—is broadly due to two causes, *viz.*, deficient demarcation by the Settlement Department, and the high rates of wages for trained labour which prevail in Khorda.

20. It is usually the custom for the demarcation operations to precede the survey by a full year; but it so happened that in Khorda no Settlement Officer was appointed until after the survey was commenced, and thus there was literally no ground prepared for the Surveyors to operate in when they arrived. After a while this evil was nearly remedied; but at first the friction engendered between the Surveyors and the Settlement Officers was very great, and complaints of retardation of survey work—by the absence of demarcation, and by alterations of boundary lines which had already been surveyed, but had to be re-surveyed—were very numerous. I was thus led to the conclusion that the attempts at simultaneous co-operation on the part of the two Departments should be discontinued; and that the Surveyors should simply survey what they see when going over the ground, without waiting for demarcations of the boundaries of villages and properties, which is always a tedious matter, and, in the case of disputed claims, can only be carried out after a more or less lengthy judicial investigation in each instance. I therefore suggested that the Surveyors should merely make a Professional Survey of the ground as they found it, and that they should then calculate the areas of the plots of land shewn on their maps; and, having done so much, that they should hand over the maps and area calculations to the Settlement Officer, leaving it to him to decide at his leisure to what villages and proprietors the several plots of land belong, and to what extent the latter should be either grouped together or further sub-divided. Thus, though the Professional Map would not serve as a record of the settlement, it would be a very valuable aid towards the settlement, and it might frequently be converted into the required record without much additional trouble.

21. On the other hand, the Board of Revenue has recommended that the operations of the Professional Surveyors should be restricted to the construction of skeleton maps, showing all the principal roads and topographical features, and the frame-work of traversed lines which is usually constructed as a basis for the filling in of the fields, and leaving the field measurements to be performed by an agency working under the Settlement Officer. The Board observe—

Paragraphs 50 and 52 of their No. 785A, dated 5th November 1876, to Government of Bengal.

"At first sight it seems that when any science is brought to bear on any subject, all that appertains to that science should be overlooked by scientific supervision; but practically it is always found that at a certain point the scientific application becomes so easy that further supervision is unnecessary. The mathematician has to prepare the tables of sines, co-sines, and logarithms, and the astronomer those by which longitude

and latitude can be determined ; but the very moderately instructed Surveyor and Navigator can apply these, once prepared, to their angles and observations without any great mathematical training. In the same way, when the Professional Surveyors have mapped on the proper scale the outer boundaries and marked in their maps the chief topographical details with all lines, stations, and points and sub-dividing lines in the interior, they have made the work so easy for the Cadastral Ameens, and the checks upon material error so numerous and effective, that the smallest modicum of knowledge, such as any officer of fair education can pick up in a few weeks or even days, suffices to enable him to supervise the work of filling in the Cadastral details for practical purposes. Even the sub-dividing lines, which would have to be demarcated on the ground, seem hardly necessary, as the Topographical details alone, and imaginary lines drawn between them, form such excellent checks against errors of measurement that little else would be needed.

"Looked at from an inter-departmental point of view, it no doubt seems most invidious to ask the professional party to do all the difficult and delicate work, to make the work for the Field Ameens easy and simple, and then, as perhaps some Surveyors may regard it, for non-professionals to step in and reap all the fruits of their skill and labour. But such a view will not bear a moment's inspection. It is obvious that if the professionals do all the difficult and scientific work, the credit equally rests with them whether the simple, but dilatory, termination is done by them or by others; and the only arguments that can possibly be allowed to weigh are the revenue and pecuniary interests of the State."

22. Now, the above sketched division of labour would probably be eagerly welcomed by most of the Professional Surveyors, as it would relieve them of an enormous amount of harassing and tedious work of supervision. Moreover the skeleton maps prepared by them for the Settlement Officers could be readily reduced from the large Cadastral scale, of 32 inches, to some smaller scale, say 2 inches to the mile, which is better suited for ordinary topographical requirements; the reductions would then need very slight additions to make them answer all the purposes ordinarily required of surveys on that scale. Such maps would be very valuable contributions to the topography of India. But it remains to be seen whether the change in the agency for supervising the measurements of the fields would cheapen the cost of that portion of the work. I believe that if the fields are to be measured at all, with a view to being mapped, as the Board of Revenue obviously contemplates, the work can be done more economically, as well as more accurately, under Professional than under Non-Professional supervision. Sines, co-sines, and logarithms are not employed by the Professional, any more than they would be by the Non-Professional supervisor of such work. The average pay of the Professional Surveyor is Rs. 246 per mensem, which can scarcely be much greater than that of any Non-Professional who would undertake the same duties. While on the other hand, the system of Field Surveying has been admirably organized, and is now working most satisfactorily ; the measurements are made very economically by men who are not given fixed wages but are paid at contract rates, which ensure a large out-turn of work; and the accuracy of the measurements is strictly tested in such a manner as to render fraud highly improbable, if not impossible.

23. I see no likelihood of effecting any material saving of expenditure otherwise than by abandoning the mapping, and having the fields measured roughly, with the avowed object of merely ascertaining their areas approximately without any intention or idea of having them mapped correctly. This would be simply a reversion to the usual method of operation in districts which are considered not to require Cadastral Survey. It is, however, to be remembered that the so-called Settlement Map thus produced is, strictly speaking, not a map at all, but only an index to the Settlement operations.

24. In the instance of Khorda, the expenditure on the Settlement operations is now greater than that on the Survey, and the cost of the two together appears to be out of all proportion to the revenue accruing to Government from the Estate. For the area is stated to be 973 square miles, and the annual revenue Rs. 1,76,516; thus the revenue is about Rs. 180 the square mile, or say 4½ annas the acre. The combined Survey and Settlement is thus being carried on at an expense which seems likely, unless both are summarily modified, to cost a sum equal to the entire revenue which will be derived from the Estate in a period of about six years. The matter is now under investigation on the spot, and I hope it may soon be satisfactorily disposed of.

PART I.

THE OPERATIONS OF THE SURVEY PARTIES LATELY APPERTAINING TO THE TRIGONOMETRICAL AND THE TOPOGRAPHICAL SURVEY DEPARTMENTS, AND THOSE OF THE SURVEYOR-GENERAL'S OFFICES.

25. The operations of some of the Survey Parties were materially influenced by the failure of the rains in Southern and Central India, during the summer of 1876, and the wide-spread famine which was consequent thereon. Two Topographical Parties of full strength were located in the Province of Mysore, and they would ordinarily have been employed in Survey operations in continuation of those of the preceding year; but it became necessary to withdraw most of the Surveyors from their usual duties and send them to the famine relief camps as assistants in the Department of Public Works; no more Surveyors were retained than were absolutely necessary to enable the perishable portion of the preliminary work of the preceding year to be at once utilized, so that it might not have to be done over again. In Rajputana water is always scanty, but this year there was none to be met with over large areas, and the Surveyors had to be transferred to other localities. This was also the case in the desert tracts of Eastern Sind. In several instances the operations, though not wholly arrested, were carried on under much privation and distress, thus causing a general diminution in the out-turn of work, as compared with what might well have been expected under less unfavourable circumstances.

I.—THE MADRAS COAST SERIES.

26. During the previous field season, Major Carter, R.E., had extended the principal triangulation, from the south, to the edge of the great plain of Tanjore, which is commonly known as the Cauvery (Káveri) delta; stations forming a hexagonal figure had been selected in advance. Lieutenant-Colonel Branfill took the field on the 17th of November, and in the first instance set to work himself, and brought the whole strength of his party to bear, on the operations for the selection of additional stations in advance. Heavy rain fell at this time and the country became a vast paddy swamp, which, though bright and green, and a glorious sight for the eyes of persons just arrived from the dried up and famine-stricken Province of Mysore, was deplorable from a Surveyor's point of view; for the ground was saturated with water, and thus to quit the high roads without sinking deep in mud and water was practically impossible; every square yard was under rice cultivation, excepting only the surfaces occupied by the villages, towns and roads.

PERSONNEL.

Lieutenant-Colonel B. R. Branfill, Deputy Superintendent, 2nd grade.
Mr. G. Belcham, Surveyor, 4th grade.
„ C. D. Potter, Asst. „ 1st „
„ A. H. Bryson „ „ 3rd „

27. The triangulation was carried over the Cauvery delta and into the valley of the Coleroon river; but this was done with very great difficulty, and only after much careful examination of the ground, with a view to finding the lines which presented fewest obstacles and greatest advantages; for the country was much wooded and it was intersected by numerous river-channels. Colonel Branfill states that but for the existence at Kumba Kónam (Comba Conum) of a lofty tower, appertaining to the Provincial College, which afforded a sufficient height (72 feet) to overlook most of the cocoanut and other trees—of which there are dense groves in and around the tower, and which are "so valuable as to make their removal prohibitory, even were their proprietors at all willing to allow them to be cut down at any valuation"—the passage of the delta might not have been effected. Further on, at Tirupanandál, a "Mandap," or detached open temple, was met with, the flat roof of which was also found to be a suitable site for a principal station. In all other cases stations had to be

specially constructed, on the general level of the ground; and the selection of suitable sites, with the minimum of trees and other obstacles on the lines between them, was a most difficult and trying operation.

28. Thus the out-turn of work, as measured either by the area covered or the length of line spanned by the final triangulation, has been small; but I believe it to be quite as much as could fairly be expected under the circumstances; for Lieutenant-Colonel Branfill is not only a very active and hard working officer, but is fertile in expedients for surmounting difficulties as they arise, and is always ready to propose any innovation on established procedure which seems likely to facilitate and expedite the operations which he is conducting.

29. The number of principal angles, measured with the great theodolite which is attached to this party, was 38, fixing 10 new principal stations, arranged so as to form two hexagonal figures which cover an area of 408 square miles. The average theoretical probable error of the angles was $\pm$ 0".21, and the average triangular error 0".84. The triangulation spans a direct distance of 39 miles from south-west to north-east, extending the series to a line across the valley of the Coleroon river, a little above the parallel of Tranquebar. Stations have been selected in advance, nearly up to the parallel of Porto Novo. A fair number (14) of the many temple-spires which stud the country were fixed, all in an area of 163 square miles exterior to the principal triangulation. An approximate connection with the levels of the Southern India Railway was effected, which is valuable as a check on the trigonometrical determination of height. Seven of Colonel Lambton's points were connected, as well as all villages and permanent land-marks visible from the stations.

30. With his Annual Report, Lieutenant-Colonel Branfill has submitted a Note on the Physiography of the Káveri delta; also a list of the proper names of stations and places that appear on the records of the past season's work, with their root meanings as far as could be gathered on the spot, and a classified statement of those that are characteristic of the country. These interesting papers have been accepted for publication by the Asiatic Society of Bengal, and are now in the Press; they have, therefore, not been introduced into the present report.*

II.—THE EASTERN FRONTIER SERIES, TAVOY.

31. The terminal side of the triangulation of the preceding and initial of the present field season rests on two hills, some 30 miles to the north of Tavoy. For the extension of the triangulation southwards, it was necessary to have a station on the group of islands known as the Middle Moscos, and another on the Southern Moscos. Mr. Rivers Thompson, the Chief Commissioner of British Burma, kindly placed the Government Steamer *Ava* at Captain Hill's disposal to enable him to visit these islands, at which the operations of the field season commenced.

PERSONNEL.

Captain J. Hill, R. E., Assistant Superintendent, 1st grade.
Mr. W. C. Price, Surveyor, 4th grade.
„ J. C. Clancey, Assistant Surveyor, 3rd grade.
„ D. J. Collins, „ „ 4th „

32. Captain Hill reports as follows:—

"We arrived at the Middle Moscos Island on the 2nd December, and I commenced my observations on the following night. I completed observations at this island on the 5th December, and, thanks to my having the *Ava*, I was able to commence work at my next station, which was on one of the Southern Moscos islands, on the night of the 8th December. At this station, which lies in latitude 13° 50′ 1″ N., I took a set of azimuth observations to two circumpolar stars, finishing my observations on the 14th December. On the afternoon of the 15th December we arrived opposite my first camping place on the mainland and landed part

* Lieutenant-Colonel Branfill reports that he has reason to be satisfied with the steady, careful, and intelligent way in which Mr. Belcham always performs his duties.

Mr. Potter had the greatest amount of difficult ground to work in; his share of the out-turn of work was small, and he was not so successful in directing his trial rays as Lieutenant-Colonel Branfill could have wished.

Mr. Bryson is said to have done a fair season's work.

of the baggage. Everything was on shore by noon next day. The *Ava* then steamed away, and the difficulties of the season began..

"The country over which the principal series had to be carried resembles very much the country triangulated during the previous year. The plains and mountains are alike covered with one uniform mantle of dense forest jungle, clearances being made here and there round villages; but these, for the most part, are almost undistinguishable when the country is viewed from a hill station. Round Tavoy the country is more open; but, as a rule, it is what I have described, and the routes are very circuitous. The march from Kiaintoung Hill Station to Nwátabo Hill Station, which takes loaded elephants eleven days to accomplish, although the direct distance between the stations is under 32 miles, may be taken as an extreme instance; but many other marches were very tedious. It is needless to particularize here my marches from one station to another through the thick forests and canes and undergrowth, where an advanced party is required to clear the way for the elephants; or to describe the mountain ascents where the elephants sometimes fell from the steepness of the improvised paths; or those pleasanter journeys when it was possible to drop down stream in a native boat to the village where I had appointed the halt. Suffice it to say, that 'unhasting, unresting,' the work went on until the 19th April, when, having been a fortnight on the top of Natyadoung hill trying unsuccessfully to penetrate the haze and get observations to my forward stations, I thought it best to wait there no longer, but return to Tavoy in time to catch the steamer for Moulmein which was to leave Tavoy on the 28th April.

"The out-turn of work is briefly as follows:—Principal observations were taken at ten stations, forming a hexagon, a quadrilateral, and a single triangle, the angles of the last named being observed on 20 zeros. An astronomical azimuth was also observed. The principal series has been advanced 65 miles, and its area has been increased by 1,748 square miles. The approximate series has been extended 148 miles. The area of the triangulation to intersected points exterior to the principal series is 1,395 square miles, thus giving a total triangulated area of 3,143 square miles. The position of the town of Tavoy has been fixed; and the position of the well-known 'Three Pagodas,' which should have been fixed during the previous season, as they constitute a most important and well-known boundary mark on our Siamese frontier, has now been determined."

33. The party suffered much in health, not so much during the progress of the field operations as afterwards, during the recess, from fever contracted in the field. Thus for several weeks Captain Hill was without any assistant, and he was consequently unable to complete all the calculations for the reduction of the observations, and to prepare the chart of the triangulation, with full numerical values, which is usually sent in at the end of the recess. He says—

"All the officers suffered more or less, and there was much illness among the Native establishment, especially among the men with Messrs. Price and Collins. A Surveyor, after half a year of continuous exposure in the heart of the Tenasserim jungles, subjected to great fatigue and many privations, often on short commons, and always obliged to content himself with the poorest diet, cannot hope for perfect health. It is a pity that there is at present no sanitarium in Burma where he can recess and repair the damage done during one field season before entering on the duties of a second. Moulmein is in many respects a very convenient head-quarters, and those who live there all the year round, taking only occasional excursions into the district, keep their health very well as a rule; but it is the general opinion of the residents that health once lost cannot often be regained there, and that a change of climate is generally essential to recovery. I have good reason for concurring in this opinion."

It appears desirable that some arrangement should be made for giving the Survey Officers in Burma periodic changes of climate to a sanitarium in India, until one of the proposed sanitaria in Burma becomes established.

34. Matters have been satisfactorily arranged with the Government of Siam, through Her Britannic Majesty's Agent and Consul General for Siam, for the execution of a chain of triangles eastwards, from the principal series in the vicinity of Tavoy to the city of Bangkok. This work, which is very desirable for geographical purposes, will be undertaken during the next field season.*

* Captain Hill states that the approximate series was vigorously prosecuted by Mr. Price, notwithstanding that he was a sufferer all through the season from fever and chest-complaints, and was several times in jeopardy of his life. He is reported to have had a narrow escape from a tiger, and on more than one occasion to have been in imminent peril in crossing in country craft on the sea, and his work was retarded by the obstructive indolence of the people.

Similar obstruction was also shown towards Mr. Collins, who was detached to determine the position of "the three pagodas." This was found to be a very difficult task, taxing to the utmost Mr. Collins' skill and energies in overcoming physical difficulties, and his tact in dealing with the people of the country and his own Native establishment; the work was done, but with what appears to be a very disproportionate expenditure of time on it, not creditable to Mr. Collins.

III.—THE EASTERN SIND SERIES, MERIDIAN 70°; AND THE OPERATIONS IN BILUCHISTAN.

35. Owing to the failure of the rains, the Party which would have been employed in the principal triangulation in Eastern Sind, could not carry on its work over the deserts in which it had to operate, and it was therefore transferred to Biluchistan.

PERSONNEL.

Captain M. W. Rogers, R.E., Officiating Deputy Superintendent, 3rd grade.
Mr. C. P. Torrens, Assistant Surveyor, 2nd grade.
Mr. P. F. Prunty, „ „ 4th grade.

36. This proved eventually to be rather a fortunate matter than otherwise; for it enabled me to send Captain Rogers to carry a secondary triangulation from the western frontier of Sind into Biluchistan, along the line between Jacobabad and Quetta. This triangulation was greatly needed, in order to rectify the maps of Biluchistan and Southern Afghanistan; for there has long been reason to believe that there are considerable errors in certain maps of those regions which at the present time are generally accepted as the most accurate of all. It has been ascertained, chiefly through the exertions of Major Wilson, when in charge of the Topographical Branch of the War Office in London, that the position in longitude which these maps give to Kandahar was a provisional value, which was adopted for preliminary requirements, with the intention of being afterwards corrected, when observations had been taken for the purpose of determining the correct longitude. Subsequently the necessary observations were taken by Lieutenant Durand, R.E., (afterwards Major-General Sir H. Durand, Lieutenant-Governor of the Punjab,) which placed Kandahar about 15 miles to the east of the assumed provisional position; but by some oversight the value thus determined was not employed in the map of Afghanistan, which was compiled in England, by the Geographer to the East India Company, and which has hitherto been accepted as the best map of the country.

37. On arrival at Jacobabad, Captain Rogers was informed by Lieutenant-Colonel Browne, R.E., on the part of Major Sandeman, the Political Agent, that there was no objection to systematic survey operations being carried on in the Cutchi, or plain country of Khelat, and in any of the hills south of the Bolan Pass, but that great caution would be necessary beyond, and guards should be provided for each Surveyor. He accordingly deputed one of his assistants to extend the triangulation from the side of the Indus series nearest to the frontier, while he himself proceeded to examine the country between the frontier and the Khelat hills, with a view to carrying a triangulation over it.

38. Pending the termination of the wintry weather on the highlands, Captain Rogers employed himself in laying out his triangles from the low hills, at the entrance of the Bolan Pass, towards Jacobabad; after accomplishing about 25 miles, he commenced his march, on the 15th of February, to Quetta. There he laid out a small triangulation in the valley, for the purpose of fixing the position and heights of the most conspicuous hills around, and connecting them with permanent marks which were put down for reference near the cantonments. These points will, I trust, be eventually connected with the main triangulation. At present their mutual distances rest on a short base line which Captain Rogers measured in the valley, and their latitudes and longitudes on his observations of the latitude of Quetta by astronomical observations, and the longitude by electro-telegraphic signals from the observatory at Bombay. On completing this work he returned through the Bolan Pass, ascending some of the hills to select stations for the future triangulation. He then joined his assistants, who were extending the triangulation from Jacobabad towards Quetta. In the Cutchi, 25 stations were selected and built; 18 were observed at, by which the series of triangles was extended 40 miles on the southern and 25 miles on the northern section. In the Quetta valley, five stations were built and observed at, 13 observations were taken for latitude, and 44 for time in the electro-telegraphic determination of the longitude of the telegraphic office, relatively to that of the Colaba observatory at Bombay, where reciprocal observations were taken. Aneroid observations were also taken daily, and time and latitude were observed at each halting-place.*

* Captain Rogers states that Mr. Torrens carried out all the operations entrusted to him in a perfectly satisfactory manner, and his work was that of a useful and hard-working surveyor.

Mr. Prunty also succeeded very well with his work; and Captain Rogers states that during the four years he has served under his orders he has always been found a willing, trustworthy, and intelligent assistant.

IV.—THE OPERATIONS IN ASSAM.

PERSONNEL.

Lieutenant H. J. Harman, R.E., Officiating Assistant Superintendent, 2nd Grade.
Mr. W. O'Sullivan, Surveyor, 4th Grade.
„ J. F. McCarthy, Assistant Surveyor, 4th Grade.

39. The principal object of the operations during the present year has been to extend the triangulation of the region between the Subansiri and the Dihang rivers as far as practicable, with a view to ascertaining which of these two affluents of the Brahmaputra river is most probably the continuation of the Sanpo river of Thibet,—the celebrated river, which, after having long been supposed to be the principal source of the Irrawaddy, has of late years been conjectured to be that of the Brahmaputra instead. As there was reason to fear that political difficulties might intervene to prevent the Survey Officers from proceeding a sufficient distance beyond the frontier to settle this much mooted point—by actual survey across the hills and up to the Sanpo river—Lieutenant Harman was directed to measure the discharges of the Subansiri, the Dihang, the Dibong, and the Brahmakund rivers, in order that by ascertaining the magnitude of the volume of water in each river, additional evidence might be brought to bear on this interesting and important geographical problem.

40. More than one programme of operations beyond the line of the frontier was submitted for the approval of the Chief Commissioner in Assam, and rejected, as liable to lead to collisions with the barbarous tribes inhabiting the regions into which it was desired to penetrate. At length, however, sanction was accorded for the Surveyors to go as far as the first high range in the Miri hills, between the Subansiri and the Dihang rivers, and also to visit the Mishmi hills, between the Dibong and the Brahmakund rivers.

41. Under instructions from the late Surveyor General, Captain Woodthorpe accompanied Lieutenant Harman to the Miri hills. The party was joined by Lieutenant Maxwell, Assistant Commissioner of North Lakhimpur, who was sent with it by the Chief Commissioner, as he had previously been in the Miri hills and knew most of the headmen of the villages. Considerable difficulties were met with in securing a sufficient number of coolies as carriers, not so much for the amount of camp equipage, which was small, but for the supplies of food which had to be carried about for the entire party; it would have been impossible to obtain any food from the Miris, for they are very poor and have barely enough to supply their own wants. Three weeks' supplies were collected at Ganditula, which is situated on the banks of the Subansiri, a few miles above where the river enters the plains. The party then moved on. The few inhabitants of the country were friendly, but the physical difficulties were great and the weather most unfavourable. Rain poured in torrents, rendering the jungle paths almost impassable, and greatly impeding the movements of the party; and when the rain ceased, the hill tops were capped with clouds, which rarely broke to enable a distant view to be obtained. With better weather the party might have advanced far into the interior, as no opposition was met with, nor any likely to be offered; but the supplies of food became exhausted, and the party had to return, after having sketched an area of about 1,500 square miles of country (on the scale of $\frac{1}{2}$ inch to the mile), and obtained a fair knowledge of about 400 square miles beyond. This included a portion of the Dihang river, higher up than any portion hitherto surveyed, but not sufficiently high to show whether the river is the continuation of the Sanpo or not.

42. After completing the work in the Miri hills, the party separated. Captain Woodthorpe proceeded to make a survey of the Mishmi hills (see para. 81), while Lieutenant Harman commenced the observations for measuring the river discharges, as follows:—

First, the Subansiri river, at Pathalipaan village, 3 miles west of the Gogah-muk Ferry, and about 10 miles below the entrance of the river into the plains; *secondly*, the Brahmaputra river, on a line due north of, and 3 miles distant from, Dibrugarh, and below the junction of the Dihang and the Dibong rivers; *thirdly*, the united stream of the Dihang and the Dibong rivers, at

1 mile below their junction, and the same distance above the junction with the Brahmaputra; *fourthly*, the Dibong river, at one mile above its junction with the Dihang, and half a mile below the junction of the Sensri river with it; *fifthly*, the Brahmaputra river, about 9 miles above Sadiya and half a mile below the junction of the united stream of the Tengapani and Noa Dihing rivers with it; and *sixthly*, the united stream of the Tengapani and Noa Dihing rivers, at about 200 yards below their junction.

43. Full details of these interesting operations—including the sectional measurements and the calculations of discharges—have been made over to the Asiatic Society for publication. It is unnecessary to say more of them in this place than that they show the volume of water of the Dihang river to be from twice to three times as great as that of the Subansiri river in different seasons of the year. This proves that, of the two rivers, the Dihang is much more likely to be the continuation of the Sanpo, though the opposite opinion has been latterly maintained, as is set forth in paragraphs 137 and 138 of the Annual Report on the Topographical Survey for last year.

44. As regards the main question, whether the Sanpo river enters the Brahmaputra river or the Irrawaddy, the evidence is not yet conclusive. The claims of the Irrawaddy to be the recipient of the Sanpo have recently been put forward, with great skill, by Mr. Gordon, Civil Engineer of the Department of Public Works in Burmah. Mr. Gordon's reasons are based mainly on the circumstance that the known volume of the great river, at various points of its course, in Upper Burma more particularly, is inconsistent with the sources of the river being so near at hand as in the hill ranges to the east of Assam, where they have been relegated ever since geographers arrived at the conclusion that the Sanpo was not the source of the Irrawaddy. Now, though in this the geographers are very probably correct, they are as probably wrong in having placed the source of the Irrawaddy so low down. Lieutenant Harman has pointed out that there is an ample area of *terra incognita*, in the regions to the north-east and east of Lhasa, to furnish a river for the Irrawaddy. And on Stanford's library map of Asia a large river—called the Sok, to the north, and the Gugbo lower down, and closely following the meridian of 96°—is shown as rising several hundred miles to the north of Assam, and eventually entering the Dibong branch of the Brahmaputra. This river may very possibly be the parent stream of the Irrawaddy: it certainly does not enter the Dibong, for Captain Woodthorpe's recent survey of the valley of that river (see paragraph 81) shows conclusively that the sources are situated at a comparatively short distance beyond the Assam frontier.*

V.—THE SECONDARY TRIANGULATION IN BURMA.

45. At the commencement of the season, Mr. H. Beverley divided his establishment into three detachments. He intended proceeding in person to resume the triangulation towards Cape Negrais and Alguada Light-house, which had already been brought down from the north to the vicinity of Bassein. Mr. Low was to resume the triangulation between Thayetmyo and Tounghoo, which was required as a connecting link between previous triangulations and to furnish additional points for

PERSONNEL.

Mr.	H. Beverley,	Surveyor,	1st grade.
„	J. Low	„	2nd „
„	J. W. Mitchell	„	4th „
„	J. O. Hughes, Asst.	„	3rd „

* Besides the above, other work had to be done to complete the triangulation in Upper Assam. The Dikrang Tower and Manabun Hills, 40 miles east of Sudyia, in the Singfu country, had still to be fixed, and the Dibrugarh-Jaipur branch series to be finished. It was also necessary to fix the position of the civil station of North Lakhimpur, and to lay down from the stations about Gauhati and Goalpara all the peaks in Bhutan not before fixed. The work last mentioned was entrusted to Lieutenant Harman's assistants, Messrs. O'Sullivan and McCarthy; the former visited 4 stations and intersected 45 peaks, and determined the heights of 26, and the latter visited 4 stations, intersected 46 peaks, and determined the heights of 28, one of which proved to be the well-known "Kunchinjenga." After doing this, Mr. O'Sullivan took up and finished the work on the branch series to Jaipur, and Mr. McCarthy observed the angles to fix Manabun and North Lakhimpur, thus completing the secondary triangulation in Assam.

topographical and geographical requirements. To Mr. Mitchell was entrusted the extension of the Rangoon and coast triangulation towards the Krishna Shoal.

46. Mr. H. Beverley succeeded in extending his chain of triangles a direct distance of 39 miles, involving the selection of 9 stations, and the clearing of 8 hill peaks and 30 miles of ray through heavy forest. More would have been done but that during the operations he was summoned away in order to select suitable sites for two lofty beacons, which it was proposed to erect on the coast line of the mainland abreast of the Krishna Shoal. The Light-house on that shoal had recently disappeared most mysteriously; whether blown over in a storm, or destroyed by the collision of a vessel, is still unknown. The Government therefore resolved that beacons should be erected on the mainland opposite the shoal, for the purposes of the Marine Survey Department. The new Light-house will be connected with them, and they are to be so constructed as to serve as stations of the triangulation also. For the latter reason, Mr. Beverley was directed to proceed to the spot, with the Assistant Engineer of the Department of Public Works, who would have to construct the beacons, in order to select the sites. The positions chosen are, one near the village of Upey, and the second at Pymbon, on Thoungyee Island. Both sites are believed to be above high spring tides; they command a good view to seaward, and seem to be on the highest ground along this low coast.

47. Mr. Low proceeded at the end of November to the two stations of his base in the interior of the Pegu-yoma hills, and cleared the heavy jungle in order to open out the view for his forward stations. He then descended to the Tounghoo side of the range to lay out the triangulation, and got as far as Yek-ken-zen hill, which he was clearing, when he was prostrated by a severe attack of fever, and was taken on to the station of Tounghoo in an insensible state. His case seemed to be hopeless at first; but he gradually recovered, and has proceeded to Europe on medical leave.

48. Mr. Mitchell wholly failed to perform the work allotted to him; but as he died while enquiries were being made as to the causes of his failure, after the termination of the field season, nothing more need be said about it. The coast triangulation, which was allotted to him, was advanced for a distance of only 6 miles; a few stations were selected further on, but not observed from. In order to obtain approximate values of the position of the beacons, a ray-trace with theodolite and perambulator was carried by Mr. Hughes from the most advanced station of the triangulation down to the sites selected by Mr. Beverley; it gives the following position values, which are probably within a few hundred yards of the truth:—

Upey ...	Latitude	...	15°	41′ 31″
	Longitude	...	95°	23′ 18″
Pymbon ...	Latitude	...	15°	44′ 59″
	Longitude	...	95°	29′ 23″

VI.—No. 1 TOPOGRAPHICAL PARTY—GWALIOR AND CENTRAL INDIA SURVEY.

49. This Party assembled at Ajmere on the 15th November 1878, with the intention of completing the detail survey of standard sheets 83, 84, and 87, in the neighbourhood of Oodeypore, west of the meridian of 74° (see index map), and between the parallels of 24° and 25° north latitude, on the standard scale of 1 inch=1 mile; a plan of the Fort of Chitorgurh on the scale of 6 inches=1 mile, and the triangulation for a plan on the scale of 12 inches=1 mile of the city of Oodeypore.

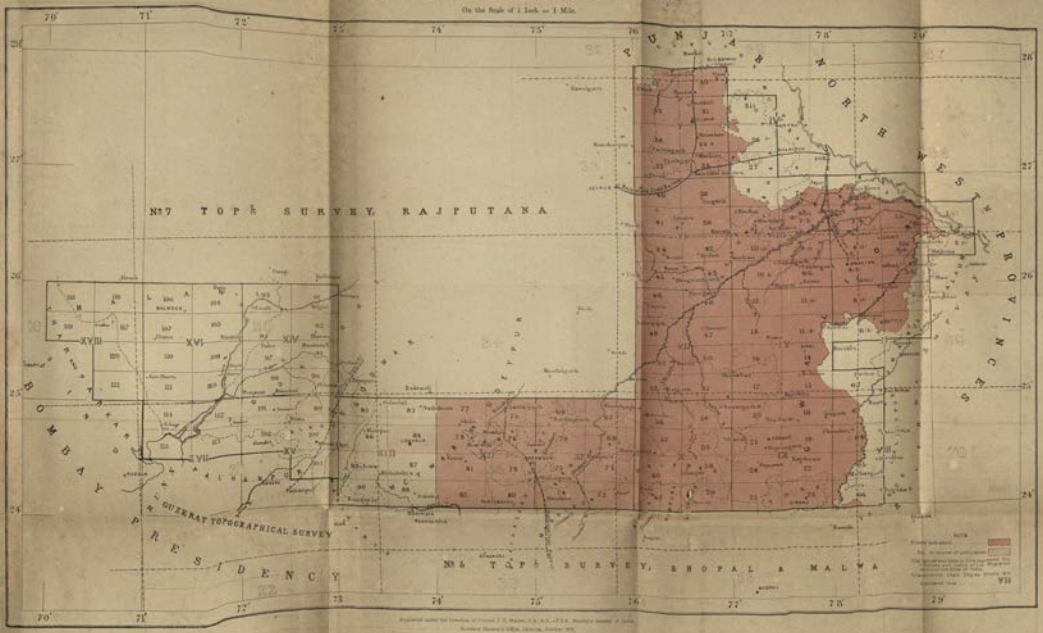
PERSONNEL.

Captain C. Strahan, R. E., Deputy Superintendent, 3rd grade, in charge.
Lieutenant J. R. Hobday, S. C., Assistant Superintendent, 3rd grade.
Mr. H. J. Bolst, Surveyor, 1st grade.
„ J. A. Vanderputt, Surveyor, 2nd grade.
„ T. E. M. Claudius, Assistant Surveyor, 1st grade.
„ C. Tapsell, „ 1st „
„ W. J. Cornelius, „ 2nd „
„ P. J. W. Doran, „ 2nd „
„ C. T. Templeton, „ 3rd „
Sub-Surveyor Jowala Pershad.
„ F. R. Harris.
„ Abdool Subhan.
„ Abdool Guffur.
„ Girdhari Lal.
„ Abdool Aziz.

No. 1 PARTY

INDEX TO THE SHEETS OF THE GWALIOR & CENTRAL INDIA TOPOGRAPHICAL SURVEY.

On the Scale of 1 Inch = 1 Mile.



50. Unfortunately, sickness and other causes intervened,* and consequently Captain Strahan was unable to complete more than about 80 per cent. of the proposed out-turn on the standard scale, from which the fair mapping of one entire standard sheet only, *viz.*, No. 84, could be completed, two other sheets remaining incomplete. The plan of Chitorgurh, however, was finished in accordance with the programme; the triangulation of Oodeypore was completed, as well as part of the detail survey of that city; and the triangulation was carried over 2,600 square miles of country in portions of Meywar, Sirohi, Edar, and Dungarpur.

51. This latter portion of the season's out-turn was entrusted to Lieutenant Hobday and Mr. Cornelius; the former officer completing 1,580 square miles, and the latter 1,020. Observations were taken at 41 stations and 400 points were fixed, which provides a larger average of points per square mile than has usually been required in most parts of the country, but were necessary on account of the intricate nature of the features in portions of that neighbourhood which, Captain Strahan anticipates, will present more difficulties to the detail Surveyors, than they have as yet encountered in any of their work.

52. The ground covered by this triangulation embraces the widest portion and the highest peaks of the Aravelli Hills, which, in this locality, extend to a width of about 60 miles, and includes the town of *Gogunda*, situated about 16 miles north-west of Oodeypore, and 2,750 feet above the level of the sea, which Captain Strahan believes to be probably the highest town in these hills. The greatest number of high peaks, he states, are to be found in this neighbourhood; but the highest of all is to be found in the Jargo Range, about 15 miles north of Gogunda. The numerous tests and checks applied to the results of this triangulation prove that the work of Lieutenant Hobday and of Mr. Cornelius is very creditable to them.†

53. The nature of the country surveyed did not admit of rigorous checks by chain lines being carried out over more than a small portion of its area; where possible, that method was adopted. In all 27·9 linear miles of test lines were made, and they afforded excellent proof of the accuracy of the portions of the survey through which they ran. In the hilly portions, Captain Strahan examined the work of the different assistants by setting up their plane-tables at various prominent places and testing the directions of all topographical items which could be seen.

54. The large number of plane-table fixings, 11·9 per square mile, is a sufficient indication of the intricacy of the country surveyed, and of the minuteness with which it was gone over.

The fair maps drawn by this party are carefully drawn, and have been reproduced satisfactorily by photozincography.

55. The boundary between the tracts previously allotted for survey by this Party, and No. 7 Party, respectively, has been altered from the parallel of 25° to that of 26°.

56. The area to be surveyed by No. 1 Party has thus been increased by about 11,000 square miles; a portion of this area had been triangulated by No. 7 Party during the preceding field season, consequently the whole of the angle books were transferred to No. 1 Party for calculation.

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* Mr. Claudius was obliged by ill health to take leave from 1st January till the 1st February; for the same reason Mr. Tapsell obtained three months' leave on medical certificate, and did not join the party in the field until the 11th January. Mr. Bolst obtained leave on urgent private affairs for two months, from the 15th February; and Mr. Vanderputt's work was found to be so inaccurate that it had to be rejected, and himself reduced in rank and pay as a punishment.

† Captain Strahan reports that the results of Lieutenant Hobday's triangulation are very fair, and would have been better if it had been possible to provide him with a greater number of heliotropes, in default of which he was obliged in many cases to make use of opaque signals, which in the jungle-covered hills of the Aravellis are extremely difficult to make out.

Mr. Cornelius used one of Cooke's 12-inch theodolites with excellent results, more particularly when it is taken into consideration that it was his first season's work.

57. During the current year this Party will take up the survey of the *Luni* River, required by the orders of the Government of India in the Department of Revenue, Agriculture and Commerce, No. 434, dated the 22nd October 1878, and will complete the blanks in the detail survey of sheets 83 and 87, which they were obliged to leave unfinished at the close of the last field season.

58. In the orders of the Government of India above quoted, the *Luni* River Survey was directed to be made on the same scale as that of the neighbouring country; but Captain Strahan having represented that, after consulting Mr. Halsey, the Officiating Commissioner of Inland Customs, he had ascertained that a map was required on a scale sufficiently large to shew all the salt pits separately, and that the scale of 4 inches=1 mile was the smallest which would answer the purpose, I directed him to carry out the survey of the *Luni* River on that scale.

59. A considerable amount of interesting matter will be found in an extract from Captain Strahan's description of the country and of the Fort of Chitorgurh, printed in the Appendix to this Report.

VII.—No. 2 TOPOGRAPHICAL PARTY—KHANDESH AND BOMBAY NATIVE STATES SURVEY.

60. This Party took the field at Bhusawal on the 1st November, with the following programme in view, *viz.*, to extend the triangulation south-westwards, in degree sheets VIII and IX, south of the Tapti River, and to continue the detail survey over the northern portion of degree sheet VIII in the Satpuras, in standard sheets 29, 30, 31, 32, and 33; the portions in the Native States and the non-revenue paying parts of Khandesh, on the scale of 1 inch=1 mile, and the valley of the Tapti, on the scale of 2 inches=1 mile.

PERSONNEL.

Mr. H. Horst,	Assistant Superintendent,	1st grade, in charge.
„ A. T. Wilson,	Surveyor,	3rd grade.
„ A. G. Wyatt,	„	4th „
„ W. F. Pettigrew,	Assistant Surveyor,	2nd grade.
„ A. Cooper,	„	2nd „
„ F. E. Warde,	„	3rd „
„ G. Vanderbeck,	„	3rd „
„ E. Graham,	„	4th „
Sub-Surveyor Sheik Omar.		
„ F. Rosario.		
„ C. George.		
„ Hyder Ali.		
„ Vishnu Moreshwar.		
„ Bapu Jadu.		
„ Mahabub Baksh.		

61. As far as the triangulation was concerned, the above programme was carried out in its entirety. Mr. A. J. Wilson, to whom this portion of the season's work was allotted, completed 2,067 square miles, observing at 98 stations, from which he fixed 275 intersected points, thus providing an average (inclusive of observing stations) of one fixed point for 5·5 square miles, as a basis for the traverses and detail survey of the 2-inch work, and determining a good portion of heights. He also fixed several stations and intersected points for the large scale survey of the city of Dhulia. A detailed description of the country through which his work was carried is given in the Appendix.

Captain Strahan reports of his assistants nearly in the following terms:—

Mr. Bolst finished his work to my satisfaction about the middle of January, and during the recess season has worked with his usual steadiness, bearing his full share of both computations and mapping.

Mr. Claudius finished about one-third of the survey of Oodeypore, including the whole of the city, and I was very well satisfied with it all. He has been engaged in office in the hill drawing of standard sheet 87, a very intricate map, which he has reduced well.

I saw *Mr Tupsell's* work at the end of the season; his accuracy as far as it could be checked by intersection seemed excellent: during the recess he assisted in the office duties entirely to my satisfaction.

Mr. Cornelius has for some years been my best plane-tabler, combining great rapidity, thorough accuracy, and good delineation of country, and it is with pleasure that I now report very favourably on him as a triangulator.

Mr. Doran's maps shew a great improvement in delineating ground; he is not a finished draftsman, but he has taken great pains to improve himself, and I am glad to say with much success.

Mr. Templeton's out-turn of 212 square miles is very good, considering the country; and his work is both accurate and well drawn.

Sub-Surveyor *Joala Pershad's* work was more minutely accurate; he has done really good work for this department since 1869, but being over 60 years of age has applied for pension.

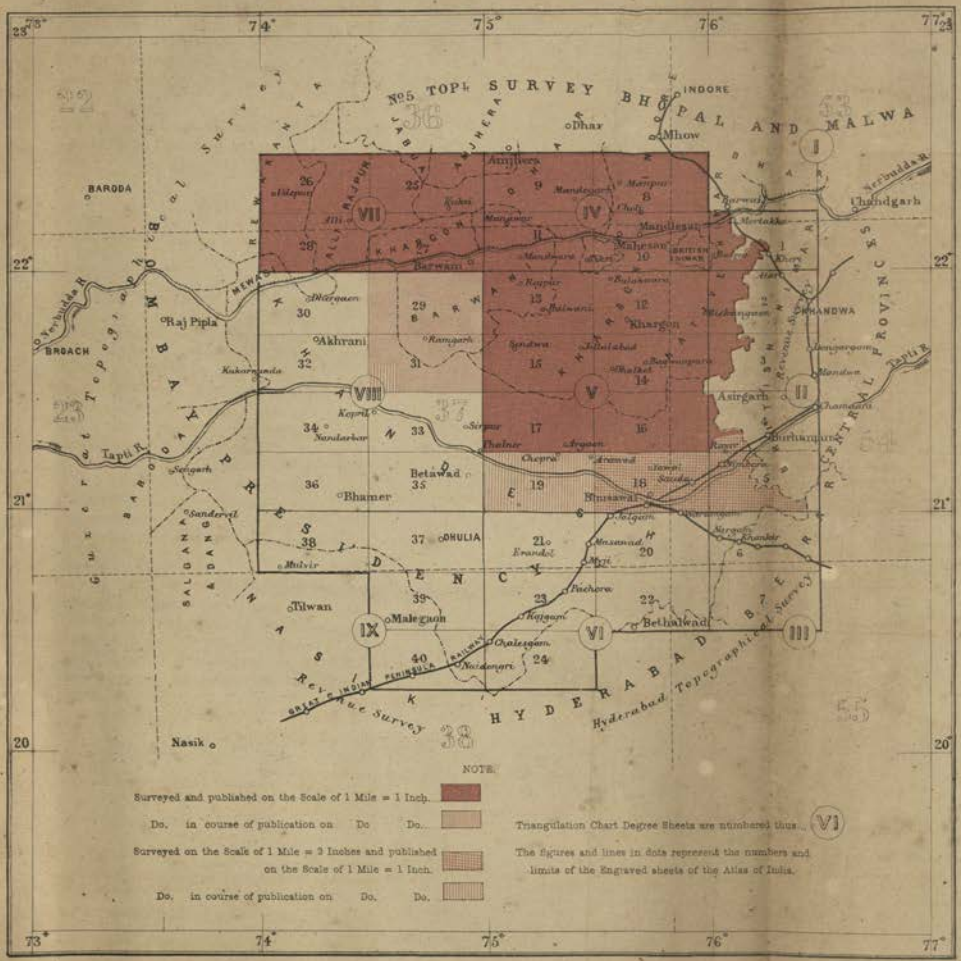
Sub-Surveyor *Abdool Sobhan* had to survey some of the most difficult bits of country which fell to our lot this season, and turned out capital work; he is my best sub-surveyor.

Sub-Surveyor *Gridhari Lal* has shewn much improvement this year.

No. 2 PARTY

INDEX TO THE SHEETS OF THE KHANDESH & BOMBAY NATIVE STATES SURVEY.

On the Scales of 1 Inch = 1 Mile and 2 Inches = 1 Mile.



NOTE.

Surveyed and published on the Scale of 1 Mile = 1 Inch.

Do. in course of publication on Do Do.

Surveyed on the Scale of 1 Mile = 3 Inches and published on the Scale of 1 Mile = 1 Inch.

Do. in course of publication on Do. Do.

Triangulation Chart Degree Sheets are numbered thus... VI

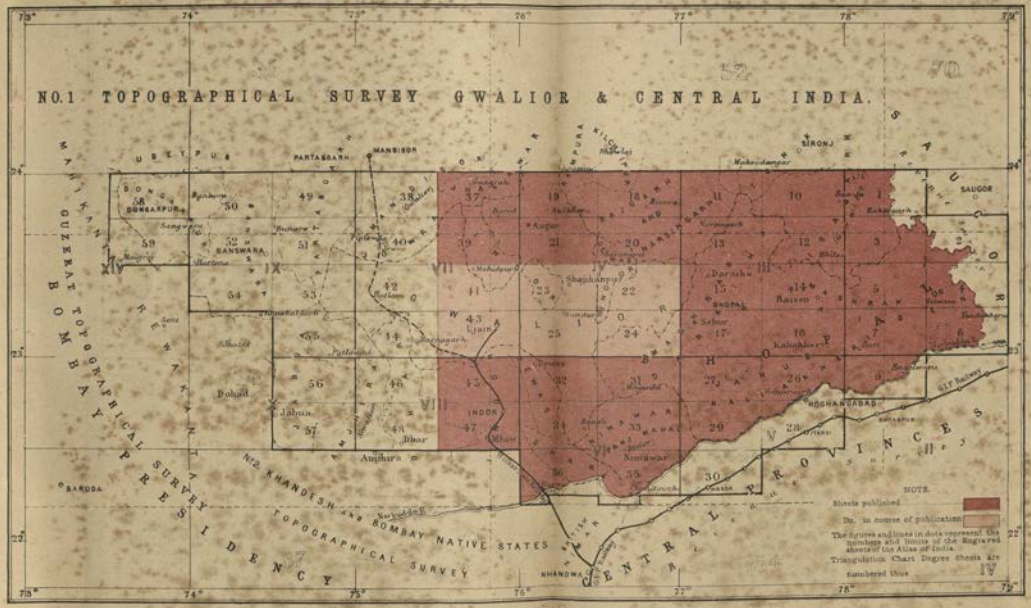
The figures and lines in dots represent the numbers and limits of the Engraved sheets of the Atlas of India.

Published under the direction of Colonel J.T. Walker, C.B., R.E., F.R.S., Surveyor General of India,
Surveyor General's Office, Calcutta, October 1876.

No. 5 PARTY

INDEX TO THE SHEETS OF THE BHOPAL & MALWA TOPOGRAPHICAL SURVEY.

On the Scale of 1 Inch = 1 Mile.



Published under the direction of Colonel J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India.
Survey of India Office, Calcutta, October 1878.

62. This Party completed the detail survey of 1442·7 square miles of country on the scale of 1 inch=1 mile, including part of the Western Satpuras, which Mr. Horst describes as "lofty plateaux and peaks, the under-features of which are very minute, and the greater portion covered with dense jungle." The work was carefully executed, and stood a reasonably rigorous test very satisfactorily; 89·2 linear miles of test line were run through this work, and numerous examinations on the spot were made by the officer in charge.

63. On the scale of 2 inches=1 mile, 585·9 square miles of country were surveyed in detail, chiefly along the valley of the Tapti, the banks of which are described as cut up by innumerable ravines: 154·2 linear miles of test line were run through the work with a result which is reported by Mr. Horst to be a satisfactory proof of its accuracy.

64. The area surveyed in detail fell short of the amount hoped for at the commencement of the season, by somewhat over 500 square miles; this deficiency Mr. Horst accounts for, as due partly to the unusually intricate nature of the ground, and partly to the extreme difficulty experienced in procuring water, which necessited greater distances being traversed daily between the camps of the Surveyors and their work, and in consequence their progress was considerably delayed.

65. The fair maps are carefully and accurately drawn and will reproduce well. They represent an area of 1,670 square miles.

66. During the ensuing field season, this party will extend the triangulation over standard sheets 6, 20 and 22, and will complete the detail survey of standard sheets 30, 32 and 33, of which the greater portions have been finished during the year under report, and of sheets 34 and 35. The portions lying in the valley of the Tapti on the scale of 2 inches=1 mile, the remainder on the scale, 1 inch=1 mile.

VIII.—No. 5 TOPOGRAPHICAL PARTY—BHOPAL AND MALWA SURVEY.

67. This Party took the field at Indore on the 9th November, its object being to complete the detail survey of standard sheets 22, 23, 24, and 25 in degree sheet IV; standard sheets 41 and 43 in degree sheet VII, and to complete a survey on the scale 12 inches =1 mile of the city and environs of Indore; also to extend

PERSONNEL.

Captain J. R. Wilmer, S. C., Officiating Assistant Superintendent, 1st grade, in charge.
*Lieutenant St. G. C. Gore, R. E., " 2nd " "
Mr. D. Atkinson, Surveyor, 2nd grade.
" C. F. Hamer, Assistant Surveyor, 1st grade.
" E. A. Wainright, " 2nd "
" H. T. Kitchen, " 2nd "
† " W. H. Lilley, " 3rd "
‡ " J. C. Murray, " 4th "
" A. Kitchen, " 4th "
" G. R. Copping, " 4th "
Sub-Surveyor Prem Raj.
" Harlal Singh.
" Kishto Dhan Chatterjee.
" Gobardan Das.
" Shib Charan.

Mr. Horst reports as follows :—

Mr. Wilson has done a large amount of work, and great credit is due to him for the energy and perseverence displayed. I always found him an able co-adjutor, setting an excellent example to his juniors.

Mr. Wyatt's reputation for accuracy and style as a plane-tabler is too well established to need further comment. He has completed, without help, the hill shading of all the standard maps.

Mr. Warde completed 177 5 square miles in excellent style. His energy and devotion to his duties both in the field and in quarters are very conspicuous.

Mr. Vanderbeck is a steady, painstaking man and very conciliatory in his manner towards the natives, but there is much room for improvement in hill drawing.

Mr. Graham is a most indefatigable surveyor, and his zeal and energy are very conspicuous both in the field and in quarters.

Sheik Omar keeps up his reputation as an excellent plane-tabler, being scrupulously correct and expeditious. He is an exceedingly useful man, steady, conscientious and painstaking.

Mr. George is a slow plane-tabler, but his work is very accurate, and as he gains confidence, he will doubtless work quicker.

Bapu Jadu shews marked improvement every year.

* Lieutenant Gore was transferred in January to the Guzerat Party.
† Mr. Lilley obtained leave on medical certificate from the 4th December to the 5th May.
‡ Mr. Murray was transferred to the Forest Department at the close of the field season.

the triangulation over the north-western portion of degree sheet VII and the eastern portions of degree sheets IX and X; but owing to the illness of Mr. Lilley during the whole season, and the transfer of Lieutenant Gore, early in the field season, the survey of Indore could not be undertaken, and the triangulation in degree sheets IX and X had to be curtailed.

68. The country triangulated covered an area of 1,865 square miles, of which 593·9 square miles were completed by Lieutenant Gore in the western portion of standard sheets 56 and 57, degree sheet X, and 1271·1 by Mr. Atkinson in standard sheets 38 and 40, degree sheet VII.

69. By this work, one fixed point to every 5·8 square miles was obtained, and one height to every 6·4 square miles; a traverse, 11 miles in length, was run round the city of Indore, fixing points for the survey on the 12-inch scale and completing the triangulation required for that survey.

70. The detail survey was carried out as had been anticipated, with the exception of the survey of the city of Indore. The area completed was 3,281·13 square miles, lying between the parallels $\frac{23}{23}-\frac{0}{30}$ and the meridian $\frac{75}{77}-\frac{30}{0}$, and was mostly easy work in open, well-cultivated tracts, of which about two-thirds lay in the Gwalior territory.

71. Through this work 217·7 linear miles of test lines were run, by which the work was shown to be in the main very correct, with the exception of one point, *viz.*, a tendency on the part of many of the Surveyors to make too much of comparatively trifling undulations, thereby giving the country the appearance of being much more hilly than it is in reality. This is rather a common failing, but if detected in the field, the fault can be corrected while the fair maps are being drawn.

72. The fair maps rendered by Captain Wilmer embrace the whole of the country which was surveyed in detail. They are in many respects fairly well drawn, but they show a want of exactitude in copying the detail from the original field sections, which in one instance is so great as to necessitate the redrawing of the map.

73. Captain Wilmer reports that fever prevailed in almost every camp throughout the season, and that cholera at times raged in the villages, causing the death of six kalassies and a chuprassy.

74. During the present field season this Party will extend the triangulation of the north-western quarter of degree sheet VII, and of the portions of the tract lying between latitude $\frac{22+30}{23+15}$ and longitude $\frac{74}{75}\frac{30}{0}$ left unfinished by the transfer of Lieutenant Gore to another Party. The detail survey will be extended over standard sheets 44, 46 and 48 on the 1 inch scale, and the survey of the cities of Indore and Dewas on the scale of 12 inches=1 mile will be undertaken.

IX.—No. 6 TOPOGRAPHICAL PARTY—KHASIA AND GARO HILLS SURVEY.

75. Lieutenant R. G. Woodthorpe, R. E., having been deputed for special work north of the Assam Valley, beyond the control of Major Badgley, the remainder of the Party took the field on the 15th November. Their programme was to extend triangulation over the south-eastern corner of the Sylhet District, to complete the revision of the detail survey on the scale 1 inch=1 mile of standard sheets 14 and 15, and, if possible, to commence that of the tract triangulated in the Sylhet District.

PERSONNEL.

Major W. F. Badgley, Officiating Deputy Superintendent, 3rd grade, in charge.
Mr. J. McCay, Assistant Surveyor, 3rd grade.
„ D. Campbell, „ „ 4th „

Captain Wilmer reports of his Assistants to the effect as follows:—

I cannot help regreting Lieutenant Gore's departure from the party, as he was of great assistance to me, always working cheerfully and steadily in the field and recess.

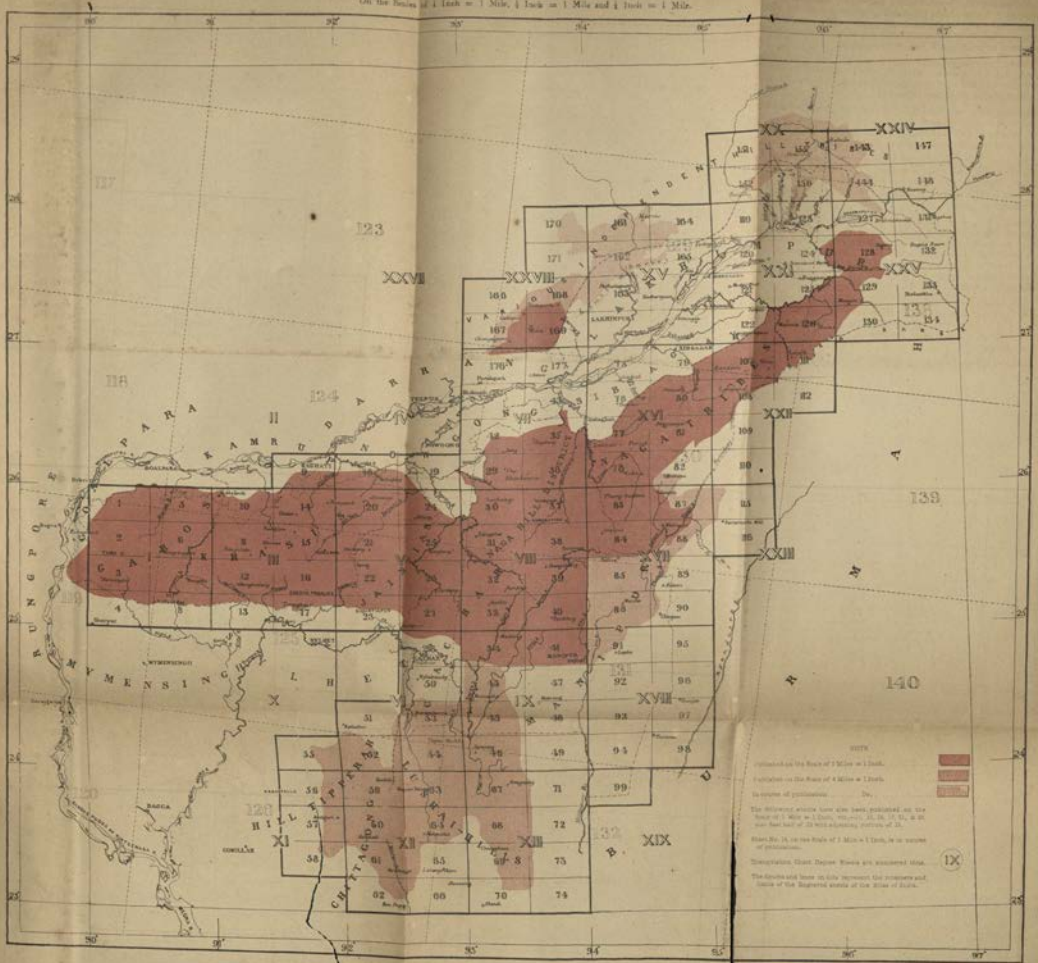
Mr. D. Atkinson has been of much assistance during recess, showing himself well up in the interior working of a Survey Party.

He also reports favorably on the work of his other European Assistants and of the Native Sub-Surveyors.

No. 6 PARTY

INDEX TO THE SHEETS OF THE GARO, KHASI AND NAGA HILLS TOPOGRAPHICAL SURVEY.

On the Scales of 1 Inch = 1 Mile, ½ Inch = 1 Mile and ¼ Inch = 1 Mile.



Published under the direction of Colonel J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India,
at the Surveyor General's Office, Calcutta, October 1875.

76. The survey of these sheets had originally been made 12 years previously, chiefly by an Assistant Surveyor, who died of malarious fever a few days after returning to recess-quarters. He probably was a man of weak physique, unable to undergo the exertion necessary for a survey of such ground, not wishing to shew either a very slow rate of progress, or his incapacity for the work; consequently the survey was defective, and the revision which has been carried out at intervals during the last two years was necessary.

77. This work, involving the survey of 282 square miles, Major Badgley entrusted to his two Assistants, after completing 40 square miles himself and assisting the junior at starting. For this work no triangulation was necessary; Major Badgley was able to identify a sufficient portion of the points fixed in 1864-65 for his purpose, not, however, without considerable difficulty, as may easily be imagined, in a country where the jungle is of such luxuriant growth. At the end of the field season Major Badgley tested this work, which he believes to have been excellently well done.

78. The triangulation in the Sylhet District, covering an area of 300 square miles, was carried out by Major Badgley, who, observing at 13 stations, fixed 49 points, or 1 to every 6·1 square miles. Part of this was computed in the field and a start made with the detail survey on the scale of 2 inches=1 mile, 19 square miles having been completed by the two Assistants before a return to recess-quarters was necessary. Very little progress was made in the large scale survey of Shillong, which Major Badgley attributes to the excessive continuance of the rainfall during the period in which his other duties would have enabled him to devote most time to that survey.

79. These figures are small as compared with the results of other parties; but, considering the nature of the ground triangulated as well as of that surveyed in detail, and the distance between the two tracts, I have no reason to believe that more could have been done. The extract from Major Badgley's report printed in the Appendix will more fully explain some of the difficulties with which he had to contend.

80. During the current season this party is expected to complete the triangulation necessary in south Sylhet, and having been strengthened by Messrs. Grant, Ogle, Chennell, and several Native Surveyors, the larger half of the detail survey on the scale of 2 inches=1 mile, of the lands referred to in my predecessor's last report, paragraph 134, should be completed.

North Brahmaputra Exploration.

81. Lieutenant (now Captain) Woodthorpe was deputed with an Assistant in the first instance to accompany Lieutenant Harman to the Miri Hills, as already reported in paragraph 41. On returning from the explorations in that region, Captain Woodthorpe proceeded to Sadiya, *viâ* Dibrugarh, to operate in the Mishmi Hills, which are situated between the Dibong and the Brahmakund Rivers. Ascending the former river in a boat, he reached Nijam Ghât, where he had been promised a supply of Mishmi carriers; but the men did not appear, probably because there had been a few cases of cholera in his camp, which created general alarm. Pushing on without assistance from the natives, he ascended a range of hills rising to 9,000 feet, which overlooked the whole of the main valley of the Dibong, called Dimba by the Mishmis, enabling him besides to form a fair idea of the courses of each of its principal tributaries. The results of the work in and around the Mishmi Hills are an accurate knowledge of the course of the Dibong and of about 1,000 square miles bordering it in the plains, and an approximate knowledge of an area of about 1,100 square miles in the hills.

Mr. Robert, Assistant Surveyor, 3rd grade.

82. This work concluded, Captain Woodthorpe returned to recess quarters at Shillong, and took charge of the entire party for two months, during Major

Mr. Roberts' share of the combined results of the work carried on under the direction of Captain Woodthorpe and Lieutenant Harman, respectively, was the completion of nearly 1,400 square miles of survey on the scale of ½ inch=1 mile, and 420 square miles on the scale of ¼ inch=1 mile. He rendered good and useful service throughout an arduous and trying field season.

Badgley's absence on leave. He also wrote an interesting report of the field season's operations, which has already been communicated to the Government, and of which extracts are given in the Appendix. He then proceeded to Mussoorie, with a view to being prepared for the charge of a new Survey Party which was about to be formed for operations beyond the Trans-Indus Frontier. On the declaration of war with Afghanistan, he was attached to General Roberts' column as Survey Officer, and he has already made many valuable additions to our knowledge of the geography of the regions to the south of the Safed Koh Range, which will be duly noticed in the next report.

X.—No. 7 TOPOGRAPHICAL PARTY—RAJPUTANA AND SIMLA SURVEY.

PERSONNEL.

Lieutenant-Colonel G. C. Depree,	Deputy Superintendent, 1st grade, in charge.
Mr. G. McGill, Surveyor,	2nd grade.
„ E. S. P. Atkinson, Surveyor,	4th „
„ R. Todd, Assistant „	1st „
„ J. H. Wilson, „ „	2nd „
Sub-Surveyor Madhusudun Dutt.	
„ John Noah.	
„ Eusuf Sharif.	
„ Imam Sharif.	
„ Kalka Pershad.	
„ J. Nathaniel.	
„ Hussain Baksh.	
„ Sher Shah.	
„ Atma Sing.	

83. This Party took the field on dates varying between the 5th and 11th November; the Rajputana detachment reaching their ground by the 20th of that month.

Distribution of the party during the field season.

* Mr McGill.
„ Atkinson.
„ Todd.
Baboo Kalka Pershad.

84. Owing to the failure of the rains in Central and Southern India, and the consequent drought, already referred to in paragraph 64 of this Report, it was not feasible to send more than a small portion of the party* to Rajputana. The remainder were employed on the large scale surveys of Kasauli and Subathu, and of the road between Simla and Kalka, under Colonel Depree's immediate supervision.

Triangulation in Rajputana.

85. The Rajputana detachment extended the triangulation over what was degree sheet XXI on the index map of this party, but which, for the reasons already stated (paragraph 56) has now become degree sheet XIV of No. 1 Party, and over the greater portion of degree sheet XX, embracing together an area of 7,772 square miles. Of this area, about 4,300 square miles (in which observations had been made at 49 stations) having been transferred to No. 1 Party, the calculations appertaining thereto were made by that party, with a result showing that 347 points (or 1 to every 9·2 square miles) had been fixed.

Out-turn of topography, Rajputana.

86. The detail survey completed in Rajputana covered an area of 1,383 square miles and embraced parts of Jodhpur and Bickaneer, lying in the south-western portion of degree sheet XII, chiefly in open country covered with low sand-hills and containing very little detail for survey. For this reason the scale of the survey was reduced from the ordinary standard scale of 1 inch to ½ an inch to the mile, which was sufficient for the requirements of the country. The average number of plane-table fixings by the detail Surveyors was 4 per square mile; the work was tested by Mr. Atkinson and reported to be satisfactory. The fair map of the southern half of this degree sheet has been neatly and accurately rendered by Colonel Depree.

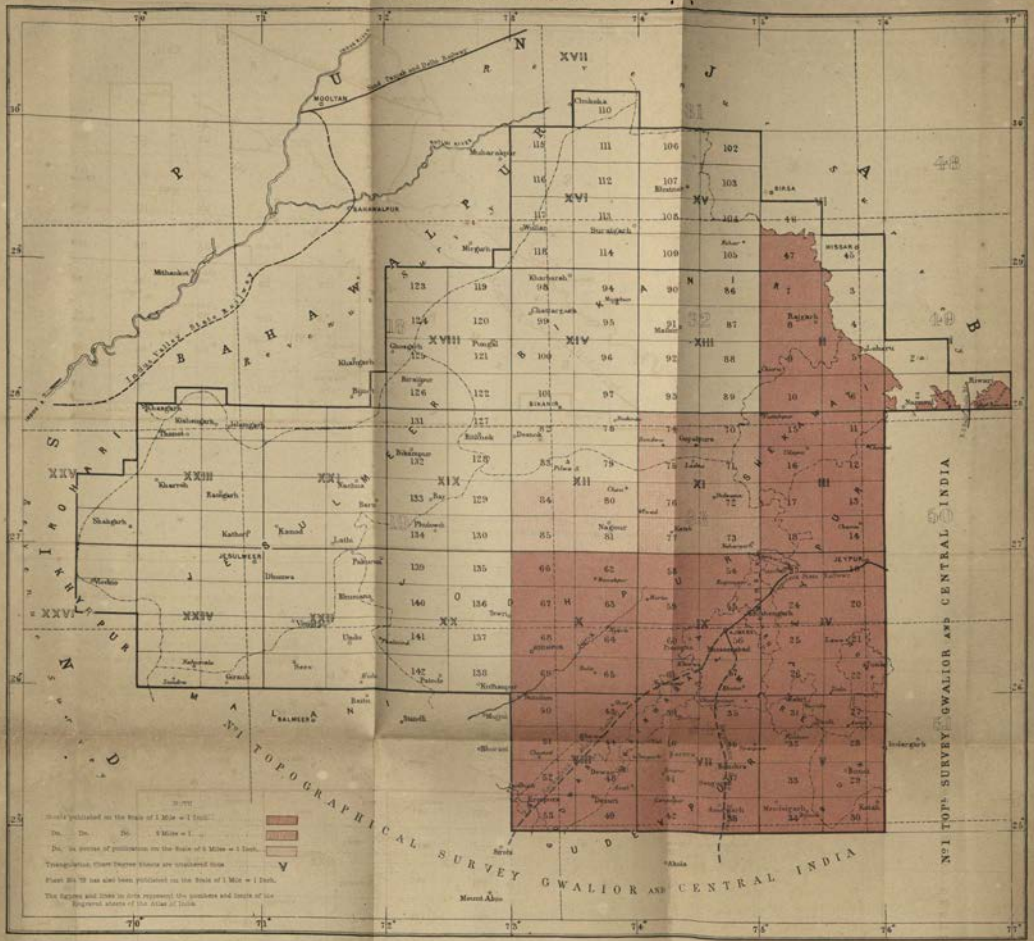
Simla and Kalka road.

87. During the recess season of 1877, triangulation extending from Simla to the neighbourhood of Kasauli and Dagshai had been made, and it formed the basis of the survey of the Simla and Kalka road. It was extended during the present field season to a distance of about 8 miles south of Kalka, on the road to Umballa.

No. 7 PARTY

INDEX TO THE SHEETS OF THE RAJPUTANA TOPOGRAPHICAL SURVEY.

On the Scales of 1 Inch = 1 Mile and ¼ Inch = 1 Mile.



Sheets published on the Scale of 1 Mile = 1 Inch.

Do. Do. Do. ¼ Mile = 1 Inch.

Do. in course of publication on the Scale of ¼ Mile = 1 Inch.

Triangulation. Great Degree Sheets are numbered thus

Plane No 72 has also been published on the Scale of 1 Mile = 1 Inch.

The figures and lines in dots represent the positions and limits of the Engraved sheets of the Atlas of India.

Published under the direction of Colonel J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India.

Surveyor General's Office, Calcutta, October 1878.

88. Surveys of the cantonments of Subathu and Kasauli were made on the scale of 24 inches to the mile, embracing an area of 2·7 square miles. Surveys were also made of the following roads, on the scale of 6 inches to the mile, *viz.*:—

Out-turn of topography. Large scale surveys.

From Simla to Chandi	... ...	... 62 miles.
„ Dharampur to Subathu *viâ* Dagshai	...	... 10 „
„ Ditto to Kasauli	... ...	... 7 „
„ Kalka to Kasauli (direct)	... ...	... 9 „

with strips of country on each side of the roads, varying in breadth from ½ mile to 1 mile. The total area surveyed on this scale is 104·81 square miles.

89. The system of topography employed by Colonel Depree for the hills on the Simla road survey and the surveys of the hill cantonments, is a combination of contour lines, sketched by eye, with other contour lines which are accurately determined by water level, are carefully followed in succession by the topographer, and are accurately delineated on the plane-table. For the maps on the 6-inch scale, the true contour lines represent vertical intervals of 250 feet, between which there are 9 eye contours at about 25 feet apart; while in the cantonment maps on the 24-inch scale, the true contour lines run at vertical intervals of 50 feet, between which there are 4 eye contours at about 10 feet apart. The method is an exceedingly valuable one, for it not only furnishes maps which are very much more accurate than any map can pretend to be which has no true contour lines, but, when once the principal contour-levels have been demarcated on the ground—by bench marks set up at convenient intervals—they can be followed and laid down mechanically on the plane-tables by men who might be quite incapable of drawing a single feature of the hills which they are surveying, and then the same men can readily add the eye contours with sufficient fidelity to nature. Thus Colonel Depree has—with the assistance of a single European Surveyor, to determine the bench marks for the contour lines—succeeded in producing by the agency of a few Native Surveyors, who had no knowledge of hill drawing on a large scale, a series of excellent maps which, though not so picturesque as if they had been turned out by skilful artists, are of greater practical value than many an apparently more finished and artistic specimen of hill drawing.

90. Colonel Depree has, at my request, drawn up a detailed account of the method of procedure which was followed. It will be found in the Appendix, and should be very valuable as a guide in future operations of a similar nature, when surveys of hilly country are required on scales larger than the ordinary standard 1-inch scale, with more of detail and greater accuracy.

91. I should here mention, however, that this system of procedure was first introduced by Lieutenant Leach, R. E., in the year 1876, after the completion of his survey of the Observatory Hill at Simla, on the large scale of 1-inch=100 feet, with a view to the erection of the new Government House at Simla. In a report dated 17th October 1877, he writes—

"The system I advocate, and I have now tested it by two years' experience, is the interpolation upon the large scale plan of levelled contours at stated intervals, and the subsequent completion of the hill drawing, based upon these contours, upon a reduced scale, according to requirements.

"With an ordinary 30-inch water-level and a little care, these contour lines can be laid down upon the ground and traversed in the ordinary way, well within the limit of accuracy that the 24-inch scale admits of, and, if desirable, spirit-level contours may be added at intervals. It is a system essentially adapted to Native Sub-Surveyors, who readily learn to contour in this way, while few attain to sufficient proficiency in hill-drawing to render reliable work. As a check upon the water-level, heights based upon instrumental observation, but computed from measured bases taken from the plane-table sections, may be added at intervals. In this way upon the 6-inch scale, the contours may be run at regular intervals of from 100 to 300 feet at the rate of 5 to 7 miles a day. When broken or precipitous ground occurs, it should be surveyed as separate detail, and also any break of continuity in the slopes intermediate between the contour lines. This is practically the system adopted by the Surveyors themselves."

92. During the current season this Party will extend the triangulation over degree sheets XIV, XV and XVI, in the northern portion of Rajputana, and

Programme for current season.

will, it is hoped, complete the detail survey on the scale of ½-inch=1 mile of the northern portion of degree sheet XII, and of the whole degree sheet XIII.

XI.—Nos. 8 AND 9 TOPOGRAPHICAL PARTIES—MYSORE.

93. This Party, which represented the aggregate strength of Nos. 8 and 9 Parties left for survey duties, after deducting 9 Surveyors and Assistant Surveyors and 7 Sub-Surveyors, who had been temporarily transferred to the Public Works Department for employment on famine relief works, took the field from Bangalore on dates varying between the 2nd and 15th November.

PERSONNEL.

Major H. R. Thuillier, R.E., Officiating Deputy Superintendent, 2nd grade, in charge.
Mr. R. W. Chew, Surveyor, 2nd grade.
„ H. E. T. Keelan, „ 3rd „
„ A. J. James, Assistant Surveyor, 1st grade.
„ W. Stotesbury, „ 1st „
„ H. Todd, „ 1st „
„ W. McNair, „ 2nd „
Sub-Surveyor Mahomed Zikeria.
„ Janki Dass.
„ Raghaveyengar.
„ Tiruvenkatsami.
„ Poonasami Pilli.

94. The detail survey of season 1876-77, owing to the distress in certain portions of the province being greater than in others, had necessarily been taken up in scattered portions, where, at the commencement of that season, hope had been entertained that the work begun might have been finished. But with the exception of standard sheets 16 and 17 in degree sheet IV, and of sheet 38 in degree sheet VIII, the work commenced in the various other sections had to be abandoned. Hence the main object of the party during the season under report was to complete the detail survey of the sheets which had been previously commenced, *viz.*, sheets 33, 34, 37, 42 and 57, and, if time and opportunity permitted, to undertake the survey of some of the State forests, which, under the orders of the Government of India, are to be carried out by this Department.

95. A very large area of triangulation in advance of the topography having been previously completed, no triangulation would have been absolutely necessary. But, observing stations had been selected and built, and marks for intersected points erected over sheets 35, 36, and part of 40 in the north, and sheets 58, 68, 69 and 70 in the south; and if these had not been utilized during this season, a large proportion of them would have had to be replaced before the triangulation could have been carried on. To save the double outlay of time and money, the triangulation was extended over 2,813 square miles of country indicated by the sheets above quoted. By this triangulation 360 points were fixed, and the heights of 317 points were determined trigonometrically.

96. The out-turn of topography completed, amounted to 2,375 square miles in country of a varied nature; some portions are reported to be of a gently undulating character, interspersed with isolated groups of low rocky hills; in others chains of hills were met, varying in height from 3,000 to over 4,000 feet above the sea-level, with the surrounding country much broken up by ravines. This area lay in the Districts of "Tumkur," "Chitaldroog," "Bangalore," "Mysore," "Hassan" and "Kolar;" 188 linear miles of test lines were run through this work, which the officer in charge reports to be carefully and accurately surveyed.

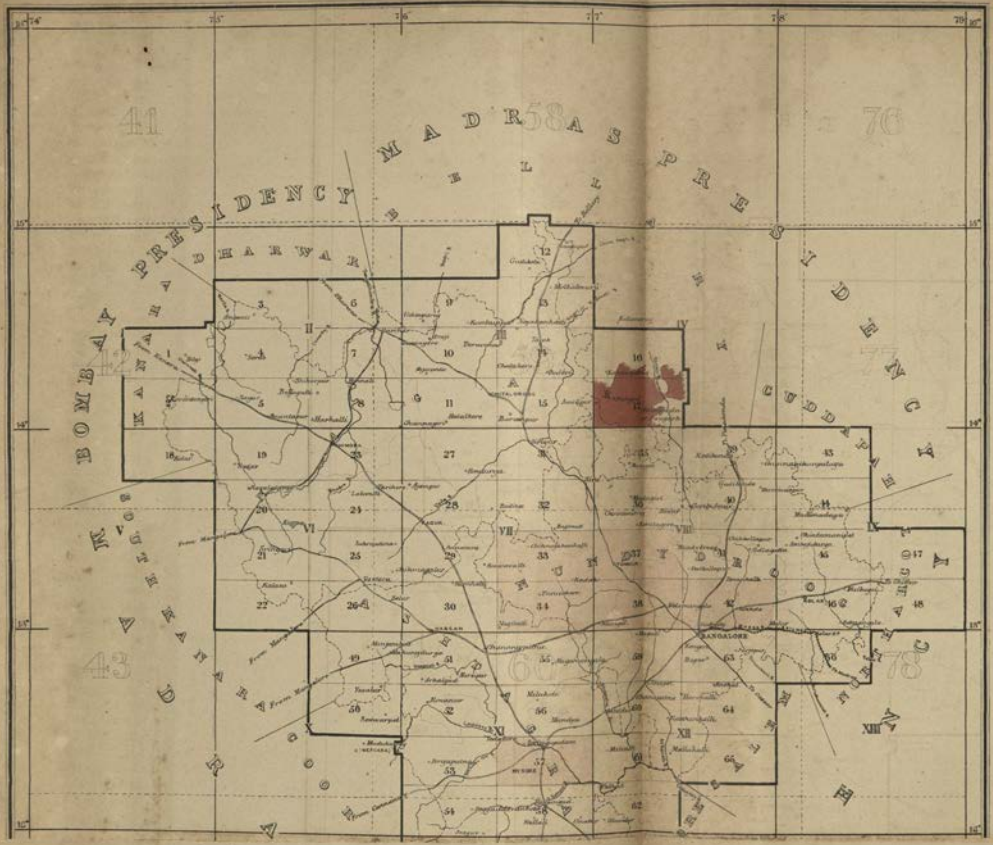
97. By this season's work four standard sheets of 30′ in longitude, and 15′ in latitude have been made available for publication in a preliminary form, and a fifth, *viz.*, No. 37, merely requires the addition of a small State forest to be complete.

98. Major Thuillier reports that, on taking the field, the prospects were better than could have been expected, considering all the trials to which the province had lately been subjected. The tanks were well filled, pasturage was abundant, and, but for the deserted look of the villages, a stranger could not have imagined that famine and drought had so lately been devastating the country. Nevertheless the season was particularly unhealthy. Fever of a virulent type broke out early in the field season in many parts of the province,

Nos. 8 & 9 PARTIES.

INDEX TO THE SHEETS OF THE MYSORE TOPOGRAPHICAL SURVEY

On the Scale of 1 Inch = 1 Mile.



and unfortunately the Tumkur District, in which the greater portion of the party was employed, was heavily struck. With the exception of the officer in charge, no single member of the European portion of the party escaped the prevalent fever. Out of the 7 Surveyors and Assistant Surveyors, 5 were forced by sickness to take leave during the field season, 4 for one month each, and the 5th for two months; and 2 out of the 5 Sub-Surveyors were incapacitated from the same cause, 1 for five weeks, and the 2nd for three months. The others also suffered more or less. The menial establishment, without a single exception, succumbed at various times to this fever, and the detached parties had frequently great difficulty in carrying on work in consequence. Under these circumstances the out-turn of the party is very creditable, for the Surveyors and Assistants stuck to their work until they could no longer move about, and returned to it again as soon as they were sufficiently convalescent to make small beginnings.

99. During the current season, the Party will extend the triangulation over degree sheets VI and X. The western portion of this is necessary, in order to meet the requirements of the Local Government with a view to the settlement of the boundary with South Canara; and as the greater portion of this tract will have to be traversed for the work connected with the frontier, the time and expense required to complete this triangulation would be comparatively small; also during the following season, when the party will have to execute the detail survey of the frontier, they will have sufficient ground prepared in the immediate neighbourhood to occupy their full working time, whereby the delays consequent on marching from one part of the country to another will be avoided. At present the party is engaged in completing the detail survey of degree sheet VIII, *viz.*, standard sheets 35, 36, 39, 40, and part of 41. Hopes are entertained that, in addition, the survey of sheets 31, 63 and 62, may be completed.

XII.—TOPOGRAPHICAL SURVEY OF GUZERAT.

100. Major Carter held the charge of this Survey from June 1877 to September 1878, and has thus had the carrying out of almost the whole of the operations of the survey year under review.

PERSONNEL.

Major T. T. Carter, R. E., Deputy Superintendent, 3rd grade.
Lieutenant St. G. C. Gore. R. E., Officiating Assistant Superintendent, 2nd grade.
Mr. T. A. LeMesurier, Assistant Superintendent, Guzerat Revenue Survey.
Mr. A. D'Souza, Surveyor, 1st grade.
„ A. Christie, „ 4th „
„ C. H. McA'Fee, „ 4th „
„ J. Bond, Assistant Surveyor, 1st grade.
„ J. Hickie, „ 2nd „
„ G. D. Cusson, „ 2nd „
„ S. F. Norman, „ 4th „
„ C. Norman, „ 4th „
Sub-Surveyor Ferns.
„ George.
„ Gopal Vishnu.
18 Native Sub-Surveyors and Apprentices.

101. The out-turn of work was very satisfactory, and is all that could be expected, considering that

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Major Thuillier reports as follows:—

Mr. Chew's out-turn was 291 square miles of topography, which I tested myself by 24 miles of route survey with a perambulator, and found it accurately and carefully done.

Mr. Keelan completed an area of 193 square miles of topography, which I examined carefully by route survey of 30 miles with a perambulator. The detail I found minute and very accurate. This first piece of work is a very creditable performance.

Mr. James completed a total out-turn of 371 square miles of topography; I examined part of his work myself, and found it very neatly and accurately executed.

Mr. Stotesbury completed a large quantity of work, *viz.*, 430 square miles of topography; I tested his sections by route surveys, 32 miles in length; he is a rapid and accurate worker.

Mr. Todd's total out-turn is 192 square miles, done with his usual care and neatness, but being in sheets which have not yet been completed, the examination has been postponed for next season.

Mr. McNair completed the triangulation of 1,595 square miles, a great part of which was in dense forest tracts, in the southern portion of the Mysore District. On the 8th March, he commenced some detail survey, and completed 128 square miles of topography, which I examined by a test line 12 miles in length, and found very accurate. The abstract of the results of his triangulation will shew that this portion of his work was well done.

Mahomed Zekeria and *Janki Das* have both done very well; they executed respectively 204 and 202 square miles of detail survey, which was tested by 55 miles of route surveys conducted by the Assistants to whom they were attached.

Raghavayengar was under instruction until the 14th January, and subsequently executed 181 square miles of detail survey, part of which was carefully tested by Mr. Stotesbury, who reports that it was minutely accurate.

the health of the men of the Native establishments, who had suffered more or less from the effects of the famine, was very bad; while at the very beginning of the season, Lieutenant Gibbs, an officer of great promise, died suddenly of cholera, as has already been mentioned in the report for last year. He was succeeded by Lieutenant Gore, who at the time was employed with No. 5 Topographical Party in the survey of Bhopal and Malwa, and was thus fortunately within a fortnight's march of the operations in Guzerat. An area of 1,820 square miles was surveyed on the scale of two inches to the mile. This area is sub-divided between British Districts and Native States as follows :—

British	Ahmedabad Collectorate	391	square miles.
	Kaira Collectorate	444	,,
	Panch Mahals Collectorate	56	,,
Native	Baroda	632	,,
	States under Mahikanta Political Agency	213	,,
	States under Rewakanta Political Agency	84	,,

The Bombay, Baroda and Central India Railway comes into the season's work at the 307th mile from Bombay; so also does a portion of the Western Rajputana State Railway, including its junction with the main line: it has been shown on the maps, though at the time of survey the embankments were being made, and in parts the line was only marked out by pegs. The Anand Pali branch of the main line also enters into the year's work.

102. In addition to the above, 68 square miles of the forest tract of the Dangs were topographically surveyed on the scale of 4 inches to the mile, by a detachment of the party under Lieutenant Gore. On account of the denseness of the forest, all the details of the ground had to be put on the plane tables by chain traversing, instead of sketching in the usual manner, and this made the work very slow and tedious. Great difficulty was experienced in obtaining appropriate and generally recognized names for the hills and minor streams, each village having its own names for its surroundings, and three or four names being occasionally applied to the same stream at different points of its course, in a distance of only a few miles. Lieutenant Gore has made a good beginning with this work which is being done—at the instance of the Government of Bombay, for the requirements of the Forest Department—on double the scale prescribed by the Government of India for the general survey of the Province of Guzerat. A contribution of Rs. 30,000 in four annual instalments,

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Major Carter reports as follows of the services of his Assistants :—

Lieutenant Gore.—I am greatly indebted to Lieutenant Gore for the zeal and energy with which he entered on this work, and his arrangements seem to have been most satisfactory. The country, as you are aware, is at all times a difficult one to work in—in the first place it is extremely unhealthy, except between the 1st March and 15th May (unfortunately this is about the hottest time of the year); secondly, all supplies have to be taken in, nothing being procurable in the country itself; and, thirdly, the water-supply is limited to that obtained from a few shallow rivers. The difficulties this year were increased owing to the scarcity of water in these rivers, due to the drought of last year, so that only certain tracts in their vicinity could be taken up, and this added considerably to Lieutenant Gore's difficulties.

Mr. LeMesurier.—The party under Mr. LeMesurier's personal supervision were employed up to the 1st February in fixing the tribettas of the British villages that came into sheets Nos. 24 and 25; subsequently Mr. LeMesurier took up the city survey of Ahmedabad for incorporation with our survey: it was drawn on 93 different sheets, on the scale of ½ a chain to the inch; these were first reduced to the scale of 3 chains to the inch by the pentagraph, and then fitted on to the traverse points projected on the same scale; the map thus produced was subsequently reduced by photography to ¼ scale, i. e., 12 chains to the inch; and from this reduced map fitted on to our work by means of proportional compasses. Subsequently, the Revenue Survey establishment were employed in plotting in the Revenue Survey details on to our plane-tables. I have to thank Mr. LeMesurier for his ready co-operation with me on all occasions.

Mr. D'Souza completed one and a half plane-tables, inspected the work of two of the Sub-Surveyors, and re-observed a chain of heights from Guzerat clock tower to Tunbara H. S., concerning the values of which there was some doubt. Subsequently he connected, by spirit levelling, the trigonometrical station of Naosari with the Great Trigonometrical Survey level bench mark at the railway station. He is reported to have rendered much valuable assistance.

Mr. Christie, after completing the triangulation in sheets Nos. 5 and 77, was employed for the rest of the season in the Dang Forests in connecting certain of the Revenue Survey traverses with trigonometrical stations by omnimeter traverses, and in fixing extra points for the large scale survey of the Dang forests. He worked hard, but in sheet No. 77 his triangular errors are said to have been larger than they should have been.

Mr. Mc d'Fee was employed in the projection of plane tables, examination of fair sections, and other duties till the 1st March, when he took up a portion of the topography of the Dang forests and completed 13½ square miles of very difficult ground. I had every reason to be well satisfied with his work.

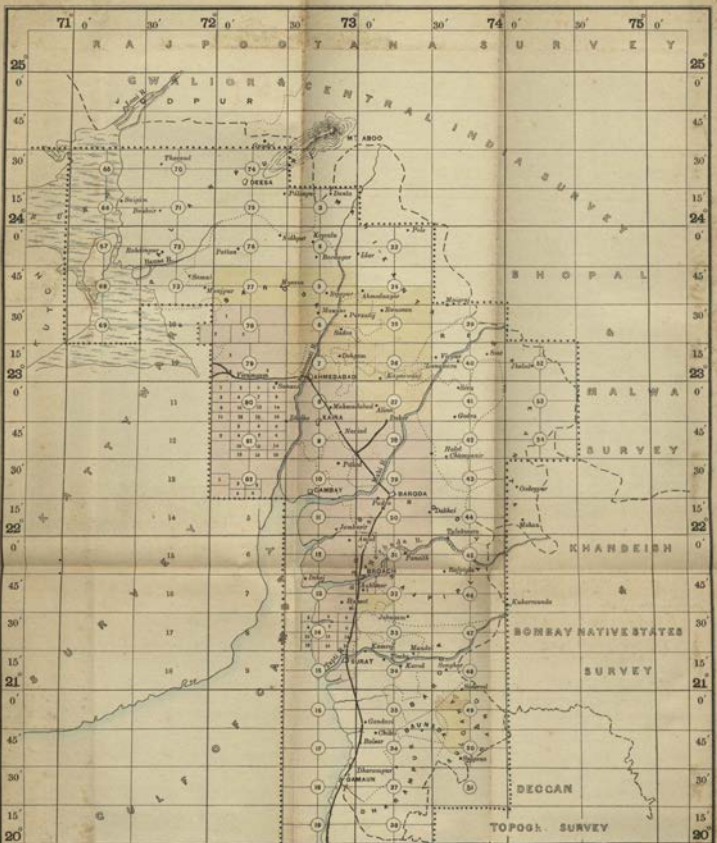
Mr. Bond was employed the whole season on triangulation, and his work is very favourably reported of.

Mr. Hickie completed two plane tables and a part of a third; one of his plane tables contained the city and cantonment of Ahmedabad; the survey of the suburbs was an intricate and difficult piece of work, being studded with the remains of old mosques and tombs.

Major Carter also expresses himself as well satisfied with the services of Messrs. Cusson, S. Norman, C. Norman, and Ferns; and he specially commends the following Native Surveyors,—Gopal Vishnu, Bhan Govind, Govind Gopal, and Syana Saibu.

GREAT TRIGONOMETRICAL SURVEY OF INDIA.

REVISED INDEX CHART OF THE GUZERAT TOPOGRAPHICAL SURVEY.



RANJIT SING, PHOTO. G. H. GILLESPIE, SCULP.

Photozincographed at the Office of the Superintendent, Great Trigonometrical Survey, Dehra Dún January 1879.

from the Budget grant of the Forest Department, has been sanctioned by the Government of India to defray the difference between the cost of the special survey and the ordinary survey on the 2-inch scale.

103. The area triangulated and traversed in advance for the topography was 2,136 square miles, giving an average of about 13 points, fixed by both processes, in an area of 10 square miles, as a basis for the interior details. The heights of 143 points were determined in addition to 105 previously fixed. The aggregate length of the lines traversed was 747 miles.

104. Good progress has been made in the mapping since the last report was sent in, and the following maps have been published:—Sheets 29, 30, 31, 79, 80, 81 and 82, on the 1-inch scale; three sections of sheet No. 79 on the 2-inch scale, and two sections of sheet No. 14 on the 4-inch scale. In addition to this, sheets Nos. 15 and 28, on the scale of 2 inches to the mile, have been drawn for reduction and publication on the 1-inch scale, and they are now being published.

XIII.—TOPOGRAPHICAL SURVEY OF KATTYWAR.

105. The operations of the field season were conducted under the supervision of Major Pullan. At the close of the field season he proceeded on furlough to Europe, when the charge of the party devolved on Mr. McGill, by whom the recess duties were carried on, and the report of the year's operations has been prepared.

PERSONNEL.

Major A. Pullan, S. C., Deputy Superintendent, 3rd grade.
Mr. John McGill, Officiating Assistant Superintendent, 1st grade.
„ F. Bell, Surveyor, 3rd grade.
„ N. C. Gwynne, „ 4th grade.
„ W. A. Fielding, Assistant Surveyor, 2nd grade.
„ G. T. Hall, „ „ 3rd „
„ H. Corkery, „ „ 4th „
„ J. Keating, „ „ 4th „
Visaji Raghunath Godboli, Head Sub-Surveyor, and eight other Sub-Surveyors.

106. Mr. McGill states that—

"in September the Political Agent of Kattywar, anticipating a famine in the province, owing to the very scanty monsoon rains, expressed doubts as to the Survey Party being able to work in Kattywar during the season; but in October some heavy showers fell, and a portion of the kharif crops was saved; and although the rain was not sufficient to bring up the grass, still it enabled the people to keep the cattle alive with the karbi of the jowari and bajri which had been sown. The people suffered from scarcity, and as grain was selling at high prices, the laboring classes in particular were in great straits for food; but there was no absolute famine, and the poorest could contrive to live and keep their family from absolute starvation."

107. Major Pullan took the party into the field earlier than usual, in the hope of being able to perform a large out-turn of work. His programme included the completion of the survey of the intricate and inhospitable tract of hills known as the Ghir, appertaining to sheet 39 of the survey; but this intention had to be abandoned, because the scanty monsoon rains had caused the streams which ordinarily flow through the Ghir to dry up, and the few hamlets that are to be met with in this wild tract had consequently been deserted. Major Pullan therefore deferred this portion of the work to the next field season, when I trust it may be completed.

108. The out-turn of field work consists of the Topographical Survey of 2,019 square miles, lying mostly in the Districts of Barda, Hallar and Soruth, and along the south-west coast line, between Diu and Porbundar; the topography was done by plane-tabling, on the scale of 2 inches to the mile, with a view to publication on the 1-inch scale. In addition to this, an area of 2,180 square miles was triangulated as a basis for future topography; and 902 linear miles of traversing was executed in surveying the taluka boundary lines and in running check lines over the topography. During the recess the whole of the fair copy maps corresponding to the field work were completed for publication on the standard 1 inch scale; and 9 sheets of the surveys of previous years were prepared for incorporation into the Indian Atlas, on the $\frac{1}{4}$ inch scale.

Considerable progress was made towards the completion of the General Reports which contain all the professional details of the survey collated together in a convenient form for future reference and preservation. The out-turn, both in field and recess, is creditable to Major Pullan and Mr. McGill.

109. It will be seen on reference to the index sheet that very little now remains to complete the survey of the Province of Kattywar. That little will probably be finished in the ensuing field season, when the party will be available for the survey of the adjoining Province of Cutch.*

XIV.—THE SURVEY OF KUMAUN AND GARHWÁL.

110. The field operations connected with the Topographical Survey of Kumaun and Garhwál having been brought to a conclusion, as stated in last Report, the work of the party was almost entirely confined to office duties connected with the preparation of the maps, all of which have been completed and published. In addition to the above, the maps of the Jaunsar-Bawur Survey have been well advanced towards completion, as well as the maps of Dehra Dun, on the scale of 1 inch to the mile.

PERSONNEL.

†Mr. E. C. Ryall, Officiating Assistant Superintendent, 2nd grade.
„ J. Peyton, Surveyor 1st grade.
„ W. Todd, „ 2nd „
„ T. Kinney, Assistant Surveyor, 1st grade.
„ R. F. Warwick „ „ 4th „
Six Native Surveyors.

111. On making a combination of the work of this survey with that of the North-West Himalaya series in 1852, when a rough topographical sketch of the hill ranges on the scale of 2 inches to the mile was executed in addition to the triangulation, considerable discrepancies were met with on the boundary of Tihri-Garhwál, and it was found that a blank of several square miles still remained for survey on the north, at the head of the Valley of Gangotri. Mr. Kinney was therefore sent to revise the old topography wherever necessary, and to survey the blank in question. He was also, if possible, to make a geographical reconnoissance of the western portion of Hundes, lying immediately to the north of his operations, which Mr. Ryall had not had time to visit in the course of the operations described in Section VIII of last year's report. Mr. Kinney has performed all this work very satisfactorily.

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* Mr. McGill reports that Mr. F. Bell worked steadily and well, completing 800 square miles of triangulation, and rendering valuable assistance in the compilation of the general reports.

Mr. Gwynne finished 232 square miles of plane-tabling and worked this season, as he has always done, very zealously and with good results.

Mr. Fielding worked well, more particularly in a tract bordering on the Portuguese Settlement of Diu, which is chiefly marshy ground and in parts under water at high tides.

Mr. Hall did good work in the country bordering on the Ghir, which is densely covered with jungle, where he had great difficulty in marking his stations and sketching his ground.

Mr. Corkery was employed on plane-tabling in the Barda hills; a very difficult and stiff piece of work, which he is reported to have done accurately and in excellent style.

Mr. Keating after completing two plane-tables was given a third in the country skirting the Ghir; his men were struck down with jungle fever and he himself suffered much from it, but he stuck to his work and finished 211 square miles of plane-tabling. He is said to be a promising young Surveyor.

Mr. McGill specially commends his Head Native Surveyor Visaji Raghunath Godboli, and the following Native Surveyors, Narsu Dinkar, Krishna Govind, Keshu Vital, Ganesh Ramchunder, Vishnu Balwant Churamun-Lall, and Ramchunder Vishnu Gupchup.

†*Mr. Ryall* had charge of this party up to the 30th September, when he was relieved by Major Carter.

Mr. Peyton's artistic skill has been utilised to great advantage on the hill shading of the sheets of the Kumaun and Garhwál and the Dehra Dún Surveys, and also in the new edition of the map of Turkestan, which is now under preparation. He has also compiled the historical account of the operations of the Kashmir Survey for the introduction to synoptical volume No. VII, which contains the numerical results of the work of the North-West Himalayan series and the Kashmir Survey.

Mr. W. Todd took a considerable part in supervising the Native draftsmen and in the computations.

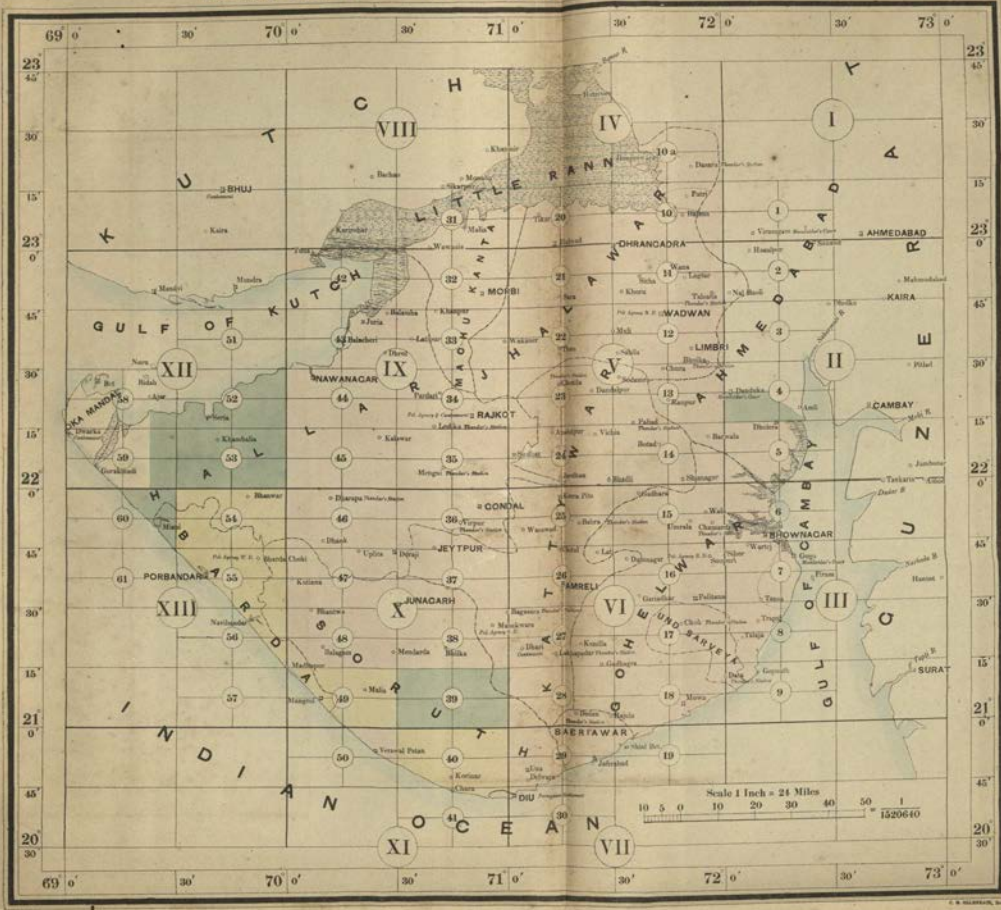
Mr. Kinney was employed in projecting and outlining the sheets of the Kumaun and Garhwál Survey, and also in doing the hill shading, in addition to the operations specified above, in paragraph III.

Mr. Warwick completed the hill shading of certain sheets of the Kumaun and Garhwál and of the Jaunsar-Bawar Surveys.

Two of the Native Surveyors took a set of observations in Jaunsar-Bawar with Captain George's mountain barometer, to fix the heights at the junction of streams, encamping grounds, and other places, which could not be fixed trigonometrically. Barometric observations were also taken at the contiguous trigonometrical stations as a check. The barometrical heights, as compared with the trigonometrical, give a mean difference of ±38 feet, ranging from −85 feet to +22 feet.

GREAT TRIGONOMETRICAL SURVEY OF INDIA.

INDEX CHART OF THE KATTYWAR TOPOGRAPHICAL SURVEY.



The numerals 1, 2, 3 &c., indicate the sheets on the scale of one inch to the mile. The numerals I, II, III &c., indicate the degree sheets, on the Scale of 1 inch to the mile.

The one inch sheets are divided into 4 sections known as the N.E., N.W., S.E., & S.W., sections of the sheet, of these a few copies will be published on the Scale of the original Survey, viz., 4 inches to the mile for the use of local officials.

——— *Denotes country Topographically Surveyed up to* 1876-77.
——— " " " in 1877-78.
——— " " *Triangulated in advance*

Photozincographed at the Office of the Superintendent Great Trigonometrical Survey, Dehra Dún, December 1878.

No. 102 A

Received the undermentioned Book on Service from the Office of the Surveyor General of India, 46 Park Street, Calcutta,

Date of Despatch.	Description of	No.	Remarks.
1879 April 24	Report for Survey Depark for 1877/78	Copies one	

Please sign receipt

The 187

To The Asiatic Society Bombay

112. Mr. Ryall has completed his promised report on Hundes, which is attached as an appendix to the present volume. He has also compiled a new map of the country, which, while containing sundry rectifications of the details given in the map executed by the brothers Strachey, is, at the same time, a proof of the skill and general accuracy with which their rapid reconnoissance was executed.

XV.—GEODETIC.

113. The electro-telegraphic operations, for the determination of differences of longitude, have remained in abeyance since the completion of the reduction of the observations connecting Bombay, Aden and Suez, which are described in Section XII of the Report on the Trigonometrical Survey for last year. The two officers, Major Campbell and Captain Heaviside, who were employed on the operations, both obtained a year's furlough, and were still absent when the survey year under review terminated.

XVI.—THE TIDAL AND LEVELING OPERATIONS.

114. In accordance with the programme of operations for obtaining a "systematic record of tidal observations on Indian coasts," which is set forth in Section XI of the Report on the Trigonometrical Survey for last year, Captain Baird has visited several of the ports, *viz.*, Bombay, Kurracheé, Carwar, Aden, Beypore, Paumben, Madras and Vizagapatam—and made the following arrangements at each port:—

PERSONNEL.

Captain A. W. Baird, R.E., Officiating Assistant Superintendent, 1st grade.
Mr. C. J. Neuville, Surveyor, 2nd grade.
„ T. H. Rendell, Assistant Surveyor, 1st grade.
„ E. J. Connor, „ 1st „
Narsing Dass and 7 Sub-Surveyors and Recorders.

At Bombay, pending the completion of the Prince's Dock, in the outer wall of which a well is being constructed for tidal observations, a self-registering tide gauge has been set up at the Apollo Bunder, in the house erected over the well for the graduated staff, which has been used for some time past by the Engineers of the Port Trust; it is, however, under contemplation to establish a tide guage permanently at the Prince's Dock as soon as possible.

At Kurrachee a self-registering tide guage had been set up some years previously, in connection with the harbour works, and its registrations have furnished the data on which Mr. Parkes has based his tidal calculations for that port; it is of small size and defective construction, but it will suffice for immediate requirements, and should not be removed until other ports, where at present there are no gauges, have been supplied. Eventually, however, Kurrachee should be provided with a guage of the best construction, and also with a self-registering anemometer and barometer, and other meteorological instruments.

At Carwar a complete set of instruments has been set up, and the registrations are now proceeding satisfactorily, though at first the clock of the tide gauge gave some trouble.

At Aden the defective tide gauge, originally erected by the local officers, has been utilized as far as practicable, pending the completion of a suitable tidal observatory which is now under construction by the Executive Engineer, and for which a complete set of instruments is waiting in readiness to be set up.

At Madras a site for a tidal observatory at the shore end of the pier, to be connected by piping with the sea, has been selected; but the construction rested with Captain J. H. Taylor, Master Attendant, and the observatory had not been completed.

At Vizagapatam an observatory was erected, and the tide gauge and other instruments had been set up and were working properly, when it was found that the man in charge—who had been taught his duties and was performing them satisfactorily—had not passed some examination which is required of Government servants in the Madras Presidency; he was therefore summarily dismissed by Captain J. H. Taylor: a new and untrained man was put in his place, and the registers became worthless.

At Paumben, on the channel between the Indian mainland and the Island of Ceylon, a suitable site was discovered after much examination, and one of the portable observatories, which had been used in the operations in the Gulf of Cutch, was being set up and connected with the sea, and it was hoped that the registrations would soon be fairly commenced.

At Beypore the configuration of the foreshore is liable to changes in the monsoons, and it was very difficult to find a place in the vicinity of deep water suited for the erection of a tidal observatory. Eventually a site was found, where it is probable that the registrations may be carried on without hindrance for a sufficient period to give fairly accurate values of the tidal elements; an observatory was being erected, all was going on favourably, and the instruments would shortly be at work.

115. At each port a man is appointed for the charge of the instruments, by the Port authorities, by whom he is paid; he is instructed by one of Captain Baird's Assistants in the manipulation of the instruments, to the extent of changing the papers on the barrels on which the daily diagrams are drawn, winding the clocks, expelling air from the pipe connecting the well with the sea, and such matters. He is also taught to read the graphic delineations of tidal height, and to enter the value for each hour, together with much collateral information, in a tabular report, which is sent off daily to Poona by post. This report keeps Captain Baird constantly informed how matters are progressing; it also serves as a duplicate record, in case of any of the diagrams being afterwards lost in transit to him. The papers on the barrels are changed once a fortnight for the tide gauge, once a week for the barometer, and every second day for the anemometer. The Port Officer exercises a general control, and corrects the clocks, usually receiving daily time signals telegraphically for the purpose.

116. It will be a part of Captain Baird's duties to calculate the tidal elements for each port from his own tidal registers, as soon as they have been carried over a sufficient period to furnish the requisite data. Already he has made such calculations for Bombay, from the registers of the observations of previous years, which were taken in connection with the harbour works. Full details of the resulting elements are given in the Appendix.

117. The method of performing these calculations having been fully described in Section X of the Trigonometrical Survey Report for last year, I need not say more here than that when once the tidal elements for any place have been determined, curves representing the momentary variations in the height of the sea-level, during any required period, past or future, may be readily constructed graphically, with the aid of a tide-calculating machine, such as the one now in the South Kensington Museum, which was designed by Sir William Thomson. The value of this machine, in reducing labour of computation, is so great, that the Secretary of State has been pleased—at my suggestion—to authorize one to be specially constructed for employment in India; it is now being made in London under the supervision of Mr. Roberts of the Nautical Almanac Office, who is introducing various modifications and improvements which his long experience of the working of the original machine—also constructed under his supervision—has shown to be desirable.

118. Spirit-leveling operations are carried on *pari passu* with the tidal observations, partly with a view to connect the tidal stations and ascertain whether there is any appreciable difference of level in the mean sea-level at the several places, and partly to connect together and reduce to a common datum the several hitherto isolated systems of levels, which have been executed throughout the country, for canals, railways, and other engineering works.

Double lines of levels—executed independently by two persons, each furnished with a first-class spirit-level, and with staves specially divided on both faces in such a manner as to afford a sure check on errors of reading—are carried over the country, from tidal station to tidal station, fixing new bench marks, and connecting with the bench marks of other systems of levels.

119. These operations have been carried on very satisfactorily during the present year, furnishing the following lines:—First, from Damaun to Bombay, completing the line which was wanted to connect the three tidal stations in the Gulf of Cutch with the one at Bombay, the greater portion having been done in previous years. Second from Bombay to Kalyán (Callian) Junction of the Great Indian Peninsula Railway, and thence up the Bhore Ghât to Poona, and down to Satara. Third, from Kalyán to the Thal Ghât and thence up the Ghât to Igutpuri, Malegaon, and finally to Chikhalwohol. In addition to these—the main lines—short branch lines were carried to connect local bench marks of importance. The aggregate length of line completed amounts to 589 miles, fixing 536 bench marks.

120. I have reason to be well satisfied with the manner in which Captain Baird has conducted the several operations entrusted to him. His organisation of the tidal observations is excellent, and the thoroughness with which he devotes himself to accomplishing whatever duty he may have to perform is very commendable.*

XVII.—THE HEAD QUARTERS OFFICES.

121. These comprise—

(1) Surveyor General's Office.
(2) The Lithographic Office.
(3) The Photographic Office.
(4) The Mathematical Instrument Office.
(5) The Revenue Survey Office, all in Calcutta.
(6) The Trigonometrical Office, at Dehra Dun.

The five Offices in Calcutta are still unfortunately in separate buildings, some distance apart from each other; for, though so long ago as in 1873 a suitable site was purchased for the construction of a set of buildings to contain the whole of the offices in one spot, there has been great delay in preparing the requisite designs, which are not yet sufficiently advanced to permit even of the foundations being laid. This is a great evil; for the present offices are not only separate from each other, but they are all too small, and they do not provide sufficient accommodation for the number of persons who have to be employed in each, for the convenient preservation of the records, and for the storage of the immense number of maps which are produced for publication. An opportunity occurred recently for the purchase of the building—No. 46, Park Street—containing the Surveyor-General's Office, which is stituated in the vicinity of the site purchased for the new offices; additions might then have been made to it to meet immediate requirements, pending the completion of the new offices, which event still seems to be as far distant as ever; but unfortunately the title deeds of the estate were found to be so defective, that the Government Solicitor advised that the purchase should not be effected. Thus we are now in great difficulties as regards office accommodation; and this causes much embarrassment, and cripples the action of the office, more particularly in the Drawing, Engraving, and Examination Branches, in the arrangement and disposition of the ever-increasing mass of original maps and records, and in the preservation of the stock of maps for general issue.

* Captain Baird reports that—

Mr. Neuville has been most pains-taking in his work, and has done a very fair season's out-turn considering this is his first year's leveling.

Mr. Rendell is said to have worked very well and to have turned out a very good season's leveling, both in quality and amount done. He is also specially commended for his energy, and for the excellent work he has done in assisting Captain Baird in the inspection of the tidal observations.

Mr. Connor has also worked hard and well, but he suffers from weak eyes and will be employed to more advantage in the computing branch of the work, as he is a quick and good computer, and has rapidly acquired a fair knowledge of the tidal reductions.

Narsing Dass worked as usual to Captain Baird's entire satisfaction.

(1) The Surveyor-General's Office.

122. This Office was deprived, for a considerable portion of the year, of the services of Mr. J. O. N. James, who after 19 years of uninterrupted service in the office under General Thuillier—with a zeal which never flagged and was warmly acknowledged by the General in every report of the operations under his administration—has been compelled to seek relief and relaxation from his multifarious duties. He was granted furlough to Europe for two years, commencing in February 1878, and Captain E. H. Steel, late of the Revenue Branch of the Department, was appointed to officiate for him.

Personnel.

Captain R. V. Riddell, R.E., Deputy Superintendent, 2nd grade, and Assistant Surveyor-General.
Mr. J. O. N. James, Deputy Superintendent, 3rd grade, and Assistant Surveyor-General,
Captain E. H. Steel, S.C., Assistant Superintendent, 2nd grade, and Offg. Assistant Surveyor-General.

Drawing Branch.

Mr. J. F. Baness, Chief Draftsman.

Drawing and Compiling.

Mr. F. Adams, Surveyor, 3rd grade.
„ W. Green, Draftsman.
„ J. R. Adels, „
„ G. B. Korper, „
Munshi Sunaulla, „
Baboo Mohesh Chunder Shah, „
Mr. J. A. Higgs, Apprentice, „
„ A. J. Musgrove, „ „
„ W. P. Smith, „ „
And 15 Native Draftsmen and Colorists.

Examining Computing, and Projecting.

Mr. A. Chamarett, Surveyor, 1st grade.
„ A. J. Wilson, „ 3rd „*
„ R. D. Farrell, „ 3rd „
„ C. A. R. Scanlan, Officiating Surveyor, 4th grade.
„ C. Tapsell, Assistant Surveyor, 1st grade.
Munshi Nubbi Buksh and 1 Native.

Keeper of Original Maps.

Mr. R. A. Gibson, Assistant Surveyor, 3rd grade.

Engraving Branch.

Mr. C. W. Coard, Superintendent.

Hill Etching.

Mr. W. Donaldson.
„ G. G. Palmer.
„ D. L. Mitchell.
„ A. G. Palmer.
„ S. M. Coard.

Hill Etching.—(contd.)

Mr. A. R. Coard, Apprentice.
„ A. W. James, „
„ A. D. Chamarett, „
Munshi Amanutoollah.
Baboo Joykristo Shaw and 3 Natives.

Outline and Writing.

Mr. J. Fulford.
And 8 Native Engravers.
Mr. O. Tarrant.
And 8 Native Engravers.

Printing.

Mr. T. B. Rodgers, Writing Engraver and Printer.
And 12 Natives.

Writer.

Baboo Kanny Lall Sen.

Correspondence Branch.

Mr. A. E. Byrn, Registrar.

Recording and Indexing.

Mr. M. Francis.
„ T. E. Ware.
Baboo Banee Madhub Banerjee.
And 1 Native.

Examining and Copying.

Mr. F. A. D'Rozario.
„ J. A. Vallis.
And 4 Natives.

Despatchers.

Baboo Bheecum Singh and one other.

Accounts, Library and Miscellaneous.

Mr. N. A. Belletty, Surveyor, 1st grade.
„ D. Byrns, Clerk.
And 2 Native Clerks.

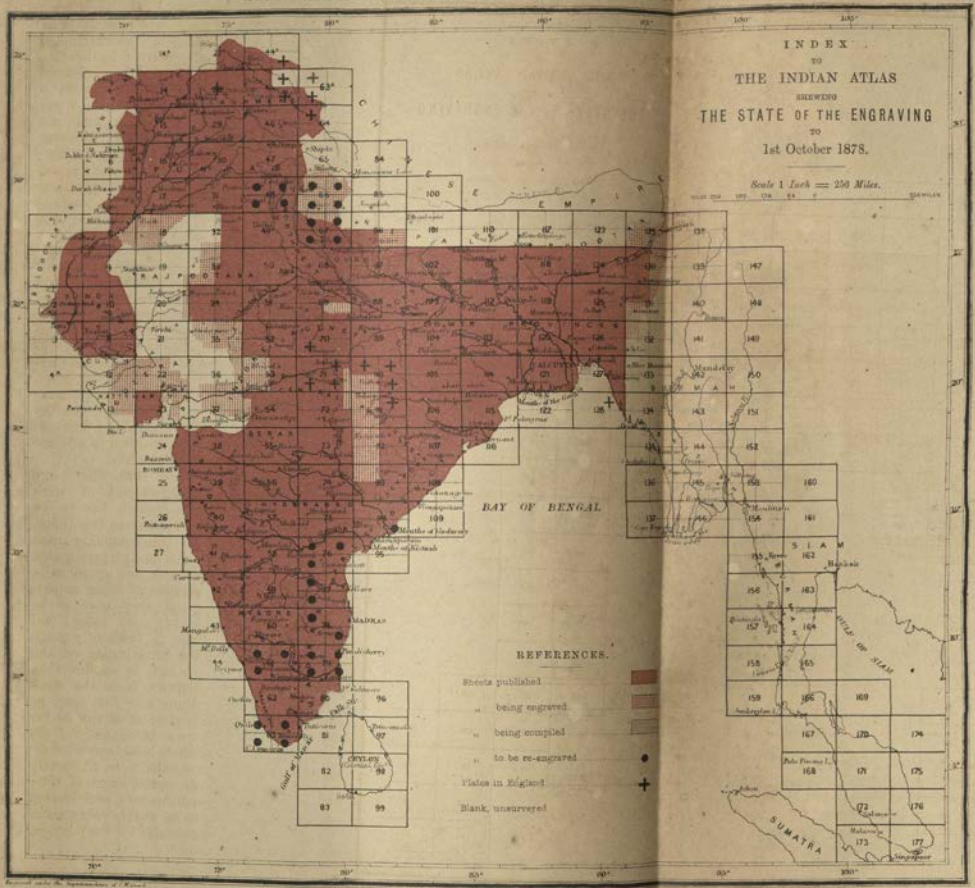
Map Issue and Stock.

Mr. T. W. Babonau, Map Curator.
„ H. R. Vallis.
„ W. P. Abro.
And 3 Natives.

123. The large amount of work which has to be done in this Office, in compiling maps and preparing data for other departments than the Survey, greatly interferes with, and occasionally deranges, the current operations of the office. The demands of other departments are usually represented to be most urgent, and they have to be immediately complied with, whatever inconvenience they may cause; and thus the progress towards completion of our own maps is frequently much retarded. And this causes no little detriment to the organization of the Office, interfering with the sub-division of labour, which is so desirable, but is impossible when men are liable to be withdrawn from the work for which they are best fitted, to undertake something else that may be more immediately wanted. With a view to rectify this state of affairs as far as practicable, and to secure a more effectual check over the accuracy of the geographical compilations and publications, and ensure their being corrected up to date—which is all the more necessary when they are liable to be frequently interrupted and to fall into different hands, during the successive stages of their progress—a separate Examining Branch has been formed this year, and located in a separate part of the building. The arrangement is working very satisfactorily, considering the cramped and limited space available for the purpose, and the results show that it was made not a day too soon.*

124. The Drawing Branch has a good out-turn of work. Fair progress has been made with the new edition of the Map of India on the scale of 1 inch=32 miles. This map is very urgently wanted, as the stock in hand of the old edition is nearly exhausted; it is being engraved on copper, but as the

* Mr. A. Chamarett, a Surveyor of considerable and varied experience, was placed in charge of this branch on its formation, and has satisfactorily discharged his duties. He has been supported by Messrs. Wilson, Farrell, Scanlan, Tapsell, and Baboo Mohesh Chunder Shaw, who have also worked well.



Published under the direction of Colonel J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India.
Surveyor General's Office, Calcutta, December 1878.

hill-etching cannot be completed on the copper for some time to come, the outlines and names are to be transferred to lithographic stones, and then the hills will be drawn rapidly on the stone to permit of early publication. The provincial maps, on the scale of 1 inch=16 miles, are being gone on with: good progress has been made with those of Bengal, the Rajputana Agency, the Central India Agency, and the Central Provinces; and a new edition of the Punjab map has been commenced. Further details of the work done in this branch of the office are given in the Appendix.*

125. The Engraving Branch has been doing good work. The maps which are put into the hands of the engravers may be broadly divided into two classes: 1st, the sheets of the Indian Atlas, on the scale of 1 inch to 4 miles; and, 2ndly, provincial and other compilations, and the Maps of India on smaller scales than the Atlas. The great demand for the sheets of the Atlas has necessarily brought the work which has to be done for it into most prominence, and caused the work on the compiled maps to be often sacrificed to it; but measures have been taken to ensure fewer interruptions in the future progress of the smaller scale maps.

126. The amount of work in the hands of the engravers is very considerable, and almost beyond the power of the Office to grasp effectively. In order that it may be restricted within the narrowest limits possible, arrangements are being made to prevent any geographical or topographical materials, which are not the results of exact survey, from being engraved on the copper. There are still many instances in which the whole of the topography of the country contained within the limits of a copper-plate has not been equally well surveyed throughout; portions may have been derived from rough preliminary surveys, or from old surveys which were good for the time they were made, but are now out of date and of little value; and if these portions are engraved *pari passu* with the results of the modern surveys, they would have to be effaced from the copper-plates, and re-engraved, as soon as exact materials become available, which would probably happen at no very distant date. In order to avoid the waste of labour and injury to the copper-plates which this would occasion, the questionable areas are either drawn on the plates in hair-lines, which can be readily effaced, or are left blank on the plates, and afterwards inserted by hand on the lithographic stones to which transfers are made from the copper-plates.

127. It has for some time been customary in this Office to print rather from the stone than from the copper, with a view to preserving the copper-plates as long as possible, and preventing them from becoming quickly worn out. At first this work was performed very satisfactorily, and the instances of failure in the transfers from copper to stone are said to have been few; but this year there have been several changes in the Office, and the failures have unfortunately been numerous; they have caused much delay and embarrassment, threatening to detract very materially from the advantages of this method of procedure. Happily the cause of failure—which was for a long time uncertain, and the responsibility of which rested between the Lithographic and the Engraving Branches—has at last been ascertained and is being rectified.

128. The Engraving Office now contains a large number of natives, who have been trained, by Mr. Coard and his Assistants, to engrave names and outlines, and generally to perform all the more mechanical portions of the work very satisfactorily. But it appears improbable that natives will attain the degree of artistic skill which is required for all hill-etching, with the exception of what may be done by closely imitating a good original, line by line. To produce a good etching in lines from a drawing in brush-work, to translate contoured lines into vertical hachures, or to give a correct delineation of the orography of a country on a small scale map by reduction from a large scale survey, requires qualifications which are possessed by only a few of our Europeans, and which are scarcely to be expected of the natives of this country. Thus the hill-etching has to be performed almost solely by the Europeans. It is slow and tedious; and so large an amount of it is waiting to be taken up, that arrangements have been made to increase the number of hill draftsmen

* Mr. J. F. Baness, Chief Draftsman, in charge of the Drawing Branch, has worked with his usual assiduity and zeal. His Assistants, Messrs. Adams, Green, and Munshis Sanaulla and Nubbi Buksh, deserve favourable mention.

in the Lithographic Office, with a view to having a certain proportion of the maps which are engraved in outline, completed, as regards the hill drawing, by lithography, which process being more expeditious and economical, is better suited for such of the maps as are liable to revisions and additions.

129. The engraving of the sheets of the Indian Atlas, which is the chief work of this branch of the office, has progressed well: 11 new quarter sheets of the Atlas have been published, 35 are in hand, and 7 have been added to; while 20 of the copper-plates of the old full sheets have had many additions, corrections, and heavy repairs made on them. The return of work, printed in the Appendix, shows the number of square inches completed on each plate of the Atlas. Fair progress has been made with the Map of India on the scale of 1 inch to 32 miles, and with the provincial maps. A good deal of miscellaneous work has also been performed, including three well executed plates to illustrate the pendulum operations, and an admirable chart of the Harbour of Colombo, for the Marine Survey Department.*

130. The Map Issue Branch has had its work much increased during the present year, because of the recent publication of a catalogue of all the maps which are published by this office; this has led to applications for maps from a large number of persons who had not previously been aware of their existence. Moreover, as it appeared that for a very long period stock had not been taken of the maps for issue, this was done on the occasion of Mr. James' succession by Captain Steel; it was found to be an exceedingly laborious undertaking

The map issues have been as follows:—

	Number.	Value.
		Rs.
To Government officials on service ...	15,515	23,733
To Agents for sale	3,752	4,960
To India Office	1,602	2,211
TOTAL ...	20,869	30,904

The stock of maps now existing in this Office for issue to the public is 308,986, and its value is Rs. 4,49,871. The amount realized by the sale of maps to private individuals at this Office and at Dehra, and by the several Map Agents, during the year 1878, was Rs. 7,824.†

131. A considerable amount of labour has been thrown on this Office by the preparation of a list of the latitudes and longitudes of all places mentioned in the *Imperial Gazetteer of India* which is now being prepared by Dr. Hunter. This work has wholly occupied two, and sometimes three of the Office Assistants since January 1878, and it is not yet completed. In order that the results may reach Scotland *pari passu* with the progress of the *Gazetteer*, the printing of which is being done there, the alphabetical list of places has been divided into three sections, comprising the several places under A and B, C to K, and L to Z, respectively. The two first sections have been forwarded to Dr. Hunter, and have reached him in good time; the third is required to, and probably will, reach him by the 1st July 1879.

132. I have reason to be much indebted to Captain Riddell for his assiduous attention to the multifarious duties which have devolved on him, more particularly since Mr. James' departure from India, as Assistant Surveyor-General and Superintendent of the Lithographic Office, and also of the Mathematical Instrument Department. Captain Steel has also done good service in various matters, and more particularly in endeavouring to introduce improvements into the organization of the Office.‡

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* Mr. C. W. Coard, the Superintendent, continues to do good service in his supervision of this branch. The senior engravers, Messrs. Donaldson, G. G. Palmer, D. L. Mitchell, J. Fulford, and O. Tarrant, have worked with their usual skill and care. The younger European engravers and the native establishment have also made good progress. On the resignation of Mr. G. Martin, plate printer, Mr. T. B. Rodger was placed in charge of the work.

† Mr. T. W. Babonau, who is in charge of the Map Issue Department, has performed in a very satisfactory manner the arduous duties of his post. Mr. R. A. Gibson, keeper of original maps and draftsman, has also done good service.

‡ Mr. E. A. Byrn, the Registrar, and Messrs. M. Francis, F. A. D'Rozario and Baboo Banee Madhub Banerjee and Bheecum Singh have discharged their several duties satisfactorily.

(2) The Lithographic Office.

133. The total number of maps, plans and diagrams, &c., printed during the year, amounts to 162,913 copies, which represents 204,963 pulls or impressions. Of these, 103,015 copies were for other departments and were of very varied character, *viz.*, diagrams of hospital necessaries for Surgeon General of British Forces, Architectural drawings for the Archæological Survey, intricate chromo-lithographic maps for the Geological Survey, &c. &c.

Personnel.

Captain R. V. Riddell, R. E., in charge.
Mr. E. Jevezy, Head Assistant and Chief Draftsman.
„ H. Lepage ... } Draftsmen.
„ C. J. Becker ... }
„ J. Musgrove ... }
Boloram Nath ... }
Soban Buksh ... }
Romanath Dass and 26 others ... }
Mr. H. Niven, Chromo-lithographic Printer.
„ E. DePyvah, Printer.
One Press Assistant and 20 others.
3 Native Clerks.

134. The most important lithographic publications which have become available during the year are as follow :—

District Dinagepore ... } Scale, 1 inch = 1 mile, each district in 13
„ Rungpore ... } sheets, measuring 40' × 25'.

Maps of the districts marginally noted, on the scale 1 inch=4 miles, obtained by transfers from the copper-plates, of the sheets of the Atlas of India, alterations to the boundaries of districts and internal sub-divisions, lines indicating railways, roads, canals, &c., being inserted on the stone and coloured by printing.

District Pertabgurh.
„ Hardoi.
„ Sitapur.
„ Kherie.
„ Gonda.

General Maps.

Atlas of India, scale 1 inch = 4 miles. The sheets specified in the margin were obtained by transfers from the engraved plates, and coloured by stone printing.

The geological map of India in 4 sheets, scale 1 inch=64 miles, two-thirds of which was prepared during last year, and which entailed 40,970 pulls.

District Umritsar, scale 1 inch=2 miles, for Punjab Government.

Map of Lucknow Division, scale 1 inch =4 miles, for Government, North-Western Provinces and Oude, Public Works Department.

¼ sheet No. 23 S. W.
„ „ 23 N. W.
„ „ 35 N. E.
„ „ 52 S. W.
„ „ 72 S. W.
„ „ 90 S. W.
„ „ 93 S. W.
„ „ 93 N. W.
„ „ 95 N. W.
„ „ 105 S. W.
„ „ 130 N. W.
Full sheets Nos. 48 and 103.

Map of British Burma, shewing boundaries of several districts, scale 1 inch =16 miles, for Government of India, Public Works Department.*

(3) The Photographic Office.

135. This Branch, under the superintendence of Captain J. Waterhouse, has continued to make satisfactory progress; and the out-turn of printed maps shows again a large increase over former years; the total number of impressions printed off being 296,329 against 245,665 of the previous year. The following table

Personnel.

Captain J. Waterhouse, B. S. C., Assistant Surveyor General, in charge.
Captain S. H. Cowan, B. S. C., (*Officiating temporarily*).

Negative Branch.

Mr. J. Mackenzie, Photographer.
„ C. Marshall, „
„ L. Lagnier, „
„ G. G. Dempster, „
And 10 subordinate Assistants.

Photographic Transfer Branch.

Mr. J. Harrold, Photographer.
Sergeant R. George, „
And 4 subordinate Assistants.

Silver Printing Branch.

Umbica Churn Bhuttacharji, Photographic Printer, and one Assistant.

Zinc Printing Branch.

Mr. B. Mackenzie, Zincographic Printer.
„ J. Watson, „ „
„ E. A. Lefranc, „ „
And 13 native zinc correctors and 12 zinc printers.

Office Establishment.

Mr. A. E. Caddy, Store-keeper.
Syad Ishmail, Head Clerk.
And 3 Native Clerks.

* Captain Riddell states that Messrs. Jevezy, Niven and Lepage, have worked cheerfully and steadily throughout the year, and he has great pleasure in recording his approbation of their labours, and thanks for their assistance. Most of the Native draftsmen are also reported to have performed their duties in a satisfactory manner.

shows the actual out-turn of work during the year, and further details will be found in Captain Waterhouse's Report given in the Appendix:—

Abstract of work performed in the Surveyor-General's Office, Photographic Branch, from 1st October 1877 to 30th September 1878.

	Sections or sheets.	Negative plates.	Photographic transfer prints.	Transfer to zinc or stone.	Number of pulls.	Number of printed sheets of each subject.			Remarks.
						Single.	Combined.	Silver prints.	
Topographical maps ...	123	247	217	133	14,425	14,790	14,140	127	
Revenue Survey maps ...	33	68	69	28	8,810	7,130	7,130	...	
District maps	3	10	10	4	1,060	1,060	1,060	...	
General maps	31	132	134	55	11,150	5,390	3,250	78	*
City and Cantonment plans...	66	127	117	48	9,160	9,160	2,790	31	
Miscellaneous Department ...	69	83	58	39	12,032	24,614	23,413	393	
Ditto Extra Department	246	526	534	196	47,228	1,01,885	98,207	208	
Proofs	...	..	...	...	3,137	...	...	...	
Cadastral Survey, Bengal ...	865	..	...	865	43,300	43,300	19,400	...	
TOTAL ...	1,436	1,193	1,139	1,368	1,50,302	2,07,329	1,69,390	837	
Cadastral Survey, North-Western Provinces ...	3,016	3,376	3,421	3,281	89,000	89,000	53,375	...	
GRAND TOTAL ...	4,452	4,569	4,560	4,649	2,39,302	2,96,029	2,22,765	837	

136. The most noticeable fact in connection with this branch of the Office is, that the arrangements for the reproduction of the cadastral plans of the North-Western Provinces are now complete, and the annual out-turn of these maps has reached the limit of about 3,000 sheets, originally estimated for. It has been found, however, that owing to the number of copies required of each plan being reduced from 50 to 25, the number of sheets reproduced may be considerably increased, and arrangements will accordingly be made for printing off a much larger number of sheets during the current year, probably between 4,000 and 5,000. Captain Waterhouse has also been able to utilise some spare presses for printing off 43,300 impressions from 865 sheets of the maps of the Bengal Cadastral Surveys, on the scale of 32 inches to the mile, zincographed from tracings prepared in the Revenue Survey Office. These sheets are not photographed. It will thus be seen that a great advance has been made in the reproduction for publication of these important surveys, but a great deal more might be done with better and more extensive accommodation for the Office.*

137. Some changes in the photographic processes adopted in the Office are noticed in Captain Waterhouse's report, particularly the preparation of collodion in the Office instead of importing it ready-made from England, by which a very large saving in cost is effected, and an improved method of preparing the photo-transfer prints upon which so much of the success and beauty of the finished work depends. The photo-electrotype process described in last year's report has also been further worked out and developed by Captain Waterhouse. This process consists in producing, by the ordinary operations of carbon or pigment printing, a raised photographic image in gelatine upon a silvered copper-plate. This gelatine relief is then electrotyped, and thus an engraved copper-plate is obtained in the course of a few days at a comparatively trifling cost. The method is applicable to the reproduction of drawings and engravings of all kinds, in line or shaded, as well as of photographs from nature; and if it can be successfully worked on a practical scale, it would prove of great value for the reproduction of shaded and coloured drawings and maps which cannot be dealt with by photozincography, and might even replace, to some extent, the costly and tedious operations of hand engraving and hill etching for some of the better class of departmental publications. The process has not as yet passed beyond the experimental stage, but I have desired Captain Waterhouse to give his best attention towards perfecting it and bringing it into a practical form.

* Captain Waterhouse continues to report favourably of the members of his office establishment, especially of the principal European Assistants, Messrs. J. and B. Mackenzie, J. Watson, J. Harrold and C. Marshall, to whose zealous co-operation the success with which the large extra amount of work now devolving upon the office has been dealt with and arranged for, is in a great measure due.

138. In July Captain Waterhouse went on privilege leave to Europe for 3 months, and, on the recommendation of the Government of India, was detained on duty by the Secretary of State for one month, to enable him to visit the Paris Exhibition and acquaint himself with the most recent improvements in the art of Photography as applied to the re-production of maps, &c. The Secretary of State also deputed him to visit Vienna to study the process of *heliogravure* practised at the Military Geographical Institute. From Captain Waterhouse's report which appears in the Appendix, he seems to have made the most of the short time at his disposal, and to have gathered a good deal of information on the special subject of his enquiries, more particularly on methods of photographic engraving and electrotyping. He also secured for the Office the right of using Mr. Willis' new Platinotype process, which promises to be a very perfect substitute for silver printing, with the great advantage of producing permanent prints. During Captain Waterhouse's absence Captain S. H. Cowan acted for him.

139. A very large proportion of the work done in this Branch has been for other Departments, as shown in the table in the Appendix. The principal items are a series of plans of barracks, &c., for the Inspector-General of Military Works; several route maps and sketches for the Quarter Master General; 25 charts for the Marine Survey Department, and a series of 73 specimens of Vernacular Hand-writing for the Post Master General.

(4) The Mathematical Instrument Office.

140. This Office receives all the instruments which have to be constructed in Europe for the Survey Operations in India, constructs all the instruments which can be made up in this country more economically than they can be obtained from England, repairs all damaged instruments, and keeps up a stock of serviceable instruments, for survey and other scientific purposes, for issue not only to the Survey Department, but to all other Departments of the public service in the Bengal Presidency. It has existed for many years, and always in connection with the Survey Department, under the superintendence either of the Deputy Surveyor-General, or of one of the senior officers stationed in Calcutta. But, for some reason or other, which is not quite clear, it has never yet been noticed in the annual reports of the Survey Department otherwise than by incidental allusions.

Personnel.

Captain R. V. Riddell, R.E., Superintendent, Mathematical Instrument Department.

Workshop Branch.

Mr. R. Wehlisch, Mathematical Instrument Maker, on furlough.
Mr. T. Bolton, Officiating Mathematical Instrument Maker.
„ F. Antram, Officiating Assistant Mathematical Instrument maker, from November 1877 to 14th September 1878, and 66 Mechanics.

Store Branch.

Mr. G. R. Alderman, Store-keeper.

Correspondence Branch.

Mr. M. O'Brien, Head Clerk.
„ J. O'Brien, Clerk, and 6 other native clerks.

141. Until lately, its duties were restricted to the receipt, issue, construction and repair of instruments, one general account of the several transactions being adjusted in the Ordnance Office. But it is now required to keep up the greater portion of the accounts, and with a far greater amount of minute detail than was ever attempted, or thought desirable, under the old system. Originally it was deemed sufficient that the instruments in store should be well cared for and readily available for issue whenever wanted, but their values were not entered in the Stock Ledgers. Now it is considered necessary that the value of every instrument in store, at any moment, should be accurately known; and this, though it can, of course, be readily given for all new instruments, is a very troublesome matter to ascertain for instruments that have undergone frequent repairs or modifications, of which no record has been kept. Moreover, the Office was originally established only for the purpose of supplying the requirements of the Survey Department, and consequently its entire cost has come to be debited against this Department; but it has long been supplying other departments also, that of Public Works more particularly; the late Surveyor-General consequently remonstrated against the Survey being saddled with an amount of

expenditure, most of which is not fairly debitable against it. This led to a call or a return of the expenses whichhad actually been incurred during the last five years on account of each department. The call was a most troublesome one to comply with ; for the accounts or the transactions of the Office had not been kept in such a manner as to give the requisite information readily. Every transaction during the five years had, therefore, to be re-examined and collated in distinctive groups. Moreover, all instruments which had been returned into store for repair or safe custody, during the period in question, had to be appraised at their existing value, in order to furnish the information needed for the new system of accounts.

142. These operations of account and appraisement have occupied the Office incessantly throughout a period of about a year and half. Happily they have now been very nearly concluded, and the Office is at last in a position to render its accounts, for the future, in a manner more gratifying to the Comptroller General's Office, than heretofore. One result of these labours is, that the value of the stock in hand on the 1st April 1877, the epoch up to which the revised accounts were brought, is greater by about Rs. 1,12,000 than had been estimated under the former system ; the instruments were, however, as well cared for then as now, and all were duly accounted for in the ledger, but this was done in the gross, and without distinctive numbers and valuation statements, such as are now furnished.

143. The values of the receipts and issues to various departments during the five years, from 1872 to 1877, were found to be as follows :—

	Issues.	Receipts.
	Rs.	Rs.
Survey Department	2,41,384	1,04,526
Public Works Department	2,74,343	61,185
All other Departments	2,45,374	88,670

The other departments consist chiefly of the Forest, the Educational, the Marine, the Meteorological, and the Civil Departments generally ; the transactions on account of the Military Department were comparatively trifling. The above figures show that only about a third of the expenditure on the working of the Mathematical Instrument Office is fairly debitable against the Survey Department, and the accounts are now adjusted accordingly.*

* The number of different kinds of instruments is about 600, of which about 300 require distinctive numbers for every instrument of each kind. The number of instruments in store in April 1878 was nearly 37,000, of which about 8,000 required separate distinguishing numbers. It will thus easily be seen that the work of registering these numbers in the Office books, and fixing them to the several instruments either by means of labels or by paint, involved considerable labour. The Store-keeper alone could not possibly have done it, even had he been possessed of a sufficient knowledge of the names of the instruments. But he was new to his duties, and scarcely knew one instrument from another ; consequently he required constant supervision, which fell to the share of Mr. Bolton.

The occasion of stock-taking was considered the best opportunity for the task of appraising and registering, because it is then customary to lend the services of a couple of Surveyors to the Office, without whose assistance the current work would inevitably come to a standstill. The stock-taking occupied over 2½ months ; and no sooner was it finished, then the internal repairs of the building were commenced by the Department of Public Works ; this necessitated one room at a time being given up, and its contents distributed in every possible manner amongst the other rooms, already over-crowded, considerably interfering with the current work of the Office.

Mr. Bolton has had to act for Mr. Woblisch, without a properly qualified assistant to take his own place. He has had to appraise some thousands of instruments, and to train a successor to the old Store-keeper, lately deceased. He also repaired and set up the photoheliograph, which is now being employed, under instructions from the Secretary of State, in examining the sun spots ; and he has made various alterations to the chronographs and other instruments employed in the electro-telegraphic determinations of differential longitudes.

But his chief mechanical work was the rectification of the 24-inch theodolite, appertaining to the Madras Trigonometrical Party. This instrument had long been troublesome to employ, as the system of microscopes for the horizontal circle was not truly centrical with regard to the circle, thus causing irregularities in the microscope readings ; and though this was of no importance *per se*, as the effects of eccentricity are eliminated in the mean of the microscope readings, it was very inconvenient and might cause gross accidental errors of reading. Moreover, the horizontal circle was not truly at right angles to the vertical axis, which caused parallax in the microscope readings. The correction of these defects, in such a manner as not to injure or distort the valuable graduated circle, on the truth of which the chief value of the instrument depends, was an exceedingly delicate and difficult matter ; it appears to have been performed very satisfactorily by Mr. Bolton, but Colonel Branfill's report on the working of the instrument since it has been returned to him has not yet been received.

The new Store-keeper, Mr. Alderman, has worked willingly and well. At first he scarcely knew one instrument from another, and had to be taught by Mr. Bolton ; but he is daily becoming more useful.

Mr. O'Brien, and the clerks in the Office, have worked with great assiduity.

(5) The Revenue Survey Office.

144. The report of the operations in this Office will be found at paras. 162 and 163.

(6) The Trigonometrical Survey Office.

145. This Office being located at Dehra Dun, at a considerable distance from Calcutta, has a Drawing and Photozincographic Branch of its own, in addition to the Computing and Printing sections, in which the primary and special work of the Office is performed.

Personnel.

J. B. N. Hennessey, Esq., M. A., F. R. S., Deputy Superintendent, 1st grade.
Major J. Herschel, R. E., Deputy Superintendent, 2nd grade
W. H. Cole, Esq., M. A., Assistant Superintendent, 1st grade.

Computing Branch.

Mr. C. Wood, Surveyor, 2nd grade
„ H. W Peychers, „ 4th grade
Babu Gunga Pershad, Computer.
„ Cally Mohun Ghose, „
„ Kally Coomar Chatterjee „
And 11 other Computers, &c.,

Printing Branch.

Mr. M. J. O'Connor, Printer.
16 Compositors and Apprentices.

Correspondence and Stores.

Mr L. H. Clarke, Surveyor, 2nd grade.
And 2 Native Writers.

Photozincographic Branch.

Mr. C. G. Ollenbach, Zincographer.
„ C. Dyson, Photographer.
2 Apprentice Photographers.
2 Native Draftsmen.
1 Apprentice Draftsman, and a Map-keeper.

Drawing Branch.

Mr. G. W. E. Atkinson, Surveyor, 3rd grade.
Jafir Khan and 4 other Draftsmen.
1 Assistant Draftsman; also 14 Apprentices and Map Colorists.

146. Much valuable work has been done, during the year, under the valued superintendence of Mr. Hennessey, full details of which are given in the Appendix. Considerable progress was made with Volume II of the Account of the Operations of the Great Trigonometrical Survey, which, I am happy to say, was completed shortly after the termination of the period under review. It is now in the hands of the book-binders in Calcutta, and is about to be issued simultaneously with Volumes III and IV, which were completed some time previously, but could not be published until No. II was also ready for publication.

147. I had hoped to have also been able to announce in this report the completion of the Account of the Pendulum Operations, but I am unfortunately unable to do so. In order to ensure early publication, the printing of the second part of this volume—which is to contain Major Herschel's reductions of the observations from the stations at which the pendulums were swung down to the sea level, and other collateral investigations—was entrusted to the Government Printing Press at Calcutta, which however discovered, in course of time, that it did not posses a sufficiency of type for the mathematical symbols and formulæ which were required. The printing was then undertaken at the Press of the Civil Engineering College at Roorkee, but again unsuccessfully. It was therefore re-transferred to Calcutta, and arrangements were made to obtain the requisite type, partly from Roorkee and Dehra, and partly from London. This has greatly retarded matters. Another, and a more serious cause of delay is due to the circumstance that Major Herschel has found it desirable to extend the scope of his investigations far beyond what was contemplated in the first instance. The original intention was that the Indian pendulum-swings should be reduced *per se*, so as to form one of the several groups of observations which will be available for combination hereafter, in investigations of the figure of the earth, and of the constitution of the earth's crust. Actually to apply the Indian observations to such investigations was no part of the original programme; but this is what Major Herschel has been endeavouring to accomplish, and as yet it is not quite clear how soon his investigations will be completed. It is a question whether they might not find a more fitting place in the journal of one of the leading scientific societies in Europe; but Major Herschel has urged that, in his opinion, "the volume on pendulum operations in India alone is the proper place for work done in the service of the Indian Government;" and he has also intimated that he is "prepared to give any required proof, in the shape of reduced emoluments for the time, of the earnestness of his convictions on this head, rather than be impelled to find expression for them in any other place than the volume (in question) which, in any case, will form one, if not the most important, work in the whole literature of the subject."

148. In addition to its current duties, the Drawing Branch has been employed in preparing a new—the fourth—edition of the Map of Turkestan, embodying all the results of the geographical information which has been acquired,

on the side of Russia and that of India, since the year 1875, when the last edition of the map was published. I trust this map will be shortly available for issue; its progress has been frequently retarded because of the geographical rectifications and new information which are now constantly arriving from various quarters. A Map of Afghanistan, enlarged from the 3rd edition of Turkestan, with such corrections and additions as were immediately needed, was prepared in about a week, and several hundred copies were supplied for the use of the Army in Afghanistan. The Printing and Photo-zincographic Branches have also been fully employed.*

149. At the Dehra Office also have been taken, during a considerable portion of the year, the solar photographs, for which the Secretary of State sent out an observer, Mr. C. Meins, trained by Mr. Norman Lockyer. The observations were to have been taken with the telescope which Mr. Meins had been instructed in the use of in England, and was to have brought with him to India, to be mounted on the equatorial portion of the photo-heliograph employed by Colonel Tennant during the observations of the transit of Venus. The telescope of Colonel Tennant's instrument was to have been sent home to be tested, with a view to the final reductions of the observations of the transit. But at the last moment Mr. Meins's telescope had to be detained in England for sundry slight additions, and it did not arrive in India until upwards of six months after he did. Meanwhile he was employed in taking photographs of the sun, daily—with Colonel Tennant's telescope—first at Calcutta, from the 11th February to 27th April; and afterwards at Dehra, to which place he was transferred as being more favourable for the observations. His work at Calcutta extended over 76 days, on ten of which sun spots were visible, three yielded faculæ, and on seven bad weather prevented observations; while on 56 days of observation no spots or markings whatever were visible. At Dehra his operations extended over 197 days, from the 23rd May to the end of December; 41 days yielded spots, 21 faculæ, and 117 blanks; while on 18 days, observations were prevented by bad weather. Mr. Meins's assiduity is highly commendable; he takes his sun pictures regularly every day, whenever the sun shines. The results are forwarded once a week to the India Office for disposal. It is to be greatly regretted that the instrument with which these photographs are being taken gives pictures of the sun which are barely more than 4 inches in diameter, and are only about one-third of the diameter of the pictures that are being taken in France by M. Jansen.

150. Mr. Duhan, my Personal Assistant, continues to render me much and valuable assistance in the general disposal of the official routine work at the Head Quarters Offices. I view with dismay the tendency which this sort of work has to increase and multiply, most unnecessarily as I cannot but think. The time which has to be expended in answering questions and supplying information on all matters connected with pecuniary disbursements is frequently out of all proportion to the importance of the information demanded; thus it seriously interferes with the rendering of due attention to objects of much greater importance as regards the general administration and execution of the operations of the Department, but which, as they are not presented in the same direct way, requiring immediate attention, are liable to be set aside to a more convenient moment or altogether lost sight of. The amount of labour and care which has now to be expended in drawing out the several bills for pay and allowances, and for contingent charges—under a variety of headings, in accordance with a number of rules and regulations, the inadvertent infraction of any one of which may lead to the return of the bills and to much correspondence, before the matter is finally disposed of—is a serious infliction, occupying far more time than should properly be devoted to matters which in reality serve rather as checks on the form in which the expenditure is exhibited, than on the actual expenditure itself, and which thus possess far less importance than is usually attributed to them.

J. T. WALKER, *Major-Genl., R. E.,*
Surveyor General of India.

February 1879.

* Mr. Hennessey warmly acknowledges the valuable and varied assistance he continues to receive from Mr. Cole. He also reports very favourably of Mr. Wood, Mr. Peychers, and Baboos Gunga Pershad and Cally Mohun, and in commendation of all his other assistants whose names are mentioned above.

Abstract of the out-turn of work executed by the Trigonometrical Parties during the Survey year 1877-78.

Description of Details.	Madras Coast Series, 24-inch Theodolite.	Eastern Frontier Series, 24-inch Theodolite.	Eastern Sind Series, 24-inch Theodolite.	Burma Secondary Triangulation, 12-inch Theodolite.	Assam Valley Triangulation, 12-inch Theodolite.	Spirit-leveling Operations.	Total.
Number of principal stations newly fixed	10	8	.....	.....	.....	.....	
„ „ triangles completed	12	10	.....	.....	.....	.....	
Lengths of principal series in miles	39	65	.....	.....	.....	.....	
Area of principal triangulation in square miles	408	1·748	.....	.....	.....	.....	
Average triangular error in seconds	·842	·54	.....	.....	.....	.....	
„ probable error of angles in seconds ±	·209	·27	.....	.....	.....	.....	
Astronomical azimuths of verification observed	.....	1	.....	.....	.....	.....	
Number of principal stations selected in advance	6	9	.....	.....	.....	.....	
Lengths of principal approximate series in advance	19	148	78	.....	.....	.....	
Number of towers, pillars and platforms, constructed for principal stations	18	7	9	.....	.....	.....	
„ scaffolds erected for principal stations	14	.....	.....	.....	.....	.....	
„ principal stations placed under official protection	12	7	.....	.....	.....	.....	
„ „ „ protected and closed	6	7	2 Towers	.....	.....	.....	
„ „ „ the elements of which have been computed	10	8	.....	.....	.....	.....	
„ secondary stations fixed	.....	.....	.....	.....	.....	.....	
„ „ triangles of which all three angles have been observed	.....	1	21	19	.....	.....	
„ „ „ of which only two angles have been observed	.....	96	107	86	.....	.....	
Lengths of secondary series in miles	.....	.....	65	44·5	.....	.....	
Area of secondary triangulation in square miles	.....	.....	398	457	1,500	.....	
„ embraced by triangulation to prominent points, hill peaks, &c., in square miles	163	1,396	1,721	2,397	.....	.....	
Number of points fixed by intersection but not visited	14	57	46	47	112	.....	
„ stations and points, the heights of which have been determined	13	50	53	57	71	.....	
„ pillars, platforms, or posts for secondary stations constructed or repaired	.....	2	23	21	.....	.....	
„ miles of rays cleared	100	5·5	202	117	.....	.....	
„ „ of pathway cleared	104	.....	.....	.....	.....	.....	
„ hill tops cleared of forest and jungle	.....	16	.....	12	.....	.....	
„ secondary stations, the elements of which have been computed	.....	60	69	62	94	.....	
„ miles levelled over	.....	.....	.....	.....	.....	589	
„ permanent bench marks fixed	.....	.....	.....	.....	.....	536	
„ preliminary charts of triangulation	1	.....	.....	1	1	.....	

Summary of results of the work of the Topographical

TRIANGULATION.

Scale of Survey.	Topographical Surveys.	Area triangulated in square miles.	Number of Stations observed at.	Number of Stations and Points fixed.		Square miles to each point.	Heights trigonometrically determined.	Square miles to each height.	Number of Triangles.			Triangular error in seconds.		Mean difference of common sides in inches per mile.			Area of Triangulation in square miles in advance of Topography.
				Stations.	Points.				1st class.	2nd class, or those of which usually all 3 angles are observed.	Tertiary, of which 2 angles only are observed.	1st class.	2nd class.	1st class.	2nd class.	Tertiary.	
1 inch = 1 mile.	No. 1 Party, Gwalior and Central India ...	2,600 4,300a	41 69a	400 *347a		6·5 11·0b	187 †	13·9 †	...	81 164b	639 562b	...	5·6	...	1·4	4·8	6,900
	No. 2 Party, Khandesh and Bombay Native States	2,067c	96	373		5·5	†	†	10	234	500	5·4	9·1	1·6	4·7	6·8	3,036
	No. 5 Party, Bhopal and Malwa	1,865	36	319		5·8	222	6·4	...	67	716	...	7·5	...	2·9	5·4	3,830
	Nos. 8 and 9 Parties, Mysore	2,813	41	360		7·8	317	8·9	...	107	737	...	3·9	...	1·1	4·8	16,850
		13,645	285	1,799		...	796	...	10	653	3,154	...	...	...	...	...	30,616
2 inches = 1 mile.	No. 6 Party, Sylhet	300	13	49		6·1	14	21·4	...	22	66	...	35·6	...	5·9	16·9	280
	Guzerat Party	1,960	123	...	583	·9d	123	15·9	...	211	948	...	15·0	...	5·3	7·2	‡
	Kattywar Party	2,180	113	90	1,012	2·0	481	4·5	...	195	1,8	...	10·8	...	3·7	10·8	1,760
		4,440	249	1,734		...	618	...	...	428	2,830	...	...	...	...	...	2,040
4 inches = 1 mile.	Guzerat Party	176	34	...	154	·8e	20	5·3	...	28	253	...	21·3	...	6·1	4·9	‡
		176	34	...	154	...	20	...	...	28	253	...	...	...	...	...	...
6 inches = 1 mile.	No. 7 Party, Simla and Kalka Road and other approaches	105	...	228		·46	324	·3	...	86	304	...	17·7	...	6·5	22·0	...
		105	...	228		...	324	...	...	86	304	...	...	...	...	...	...
24 inches = 1 mile.	No. 7 Party, Kassauli and Subathu Cantonments	2·7	...	254		·01	5	...	...	72	354	...	38·2	...	48·5	39·9	...
		2·7	...	254		...	...	...	...	72	354	...	...	...	...	...	...
8 inch = 1 mile.	No. 7 Party, Rajputana	3,472	†	†	†	†	†	†	†	†	†	†	†	†	†	†	10,700
	Kumaon and Gurhwal Party	150	10	...	49	6·1	25e	6·0	...	...	...	...	...	...	...	...	...
		3,622	10	...	49	...	25	...	...	...	...	...	...	...	...	...	10,700
	Totals ...	21,991	577	4,718		...	1,783	...	10	1,267	6,895	...	...	...	...	...	49,356

(a). Triangulated by No. 7 Party.
(b). Computed by No. 1 Party.
(c). Includes triangulation for the 2" survey.
(d). Includes points by traverse.
(e). Besides 214 heights barometrically determined

* For 3,800 square miles.
† Not yet computed.
‡ Not given.
§ Included in the number given for 6" survey.

Parties between 1st October 1877 and 30th September 1878.

Scale of Survey.	Topographical Survey.	Traverses. Instrument used.	Traverses. Linear miles traversed.	Traverses. Number of stations at which the Theodolite was set up.	Traverses. Average error per 1,000 links.	Traverses. Average angular error per station in seconds.	Traverses. Number of village trijunctions fixed.	Traverses. Number of points fixed by traverse and their elements computed.	Topography. Final topography in square miles completed during season.	Topography. Average number of plane-table fixings per square mile of detailed survey.	Topography. Total area of final mapping rendered in square miles.	Topography. Linear miles of check lines traversed.	Names of districts, talukas, mehals, &c., through which the season's operations have been carried.
1 inch = 1 mile.	No. 1 Party, Gwalior and Central India	...	...	...	...	...	...	...	1306·9	11·9	541	27·9	Sirohee, Jodhpore (Marwar), Dongarpur, Edar and Oodeypore (Meywar)
	No. 2 Party, Khandesh and Bombay Native States	...	...	...	...	...	...	...	1442·7	8·3	1,115	67·2	Pati, Pansemal and Rajpur of Barwani, Shirpur and Tolada of Khandesh.
	No. 5 Party, Bhopal and Malwa...	...	...	...	...	...	...	...	3281·2	6·6	3281·2	217·7	Bhopal, Dewas, Sundarsi, Gwalior Indore, Dhar, Rajgarh, and Narsingarh.
	No. 6 Party, Khasi Hills ...	...	...	...	...	...	...	...	282	7·5	1,055	...	Khasi hills.
	Nos. 8 and 9 Parties, Mysore ...	...	...	...	...	...	...	...	2,375	7·0	2,895	188	Tumkur, Chitaldroog, Bangalore, Mysore, Hassan and Kolar.
			...	...	...	...	...	...	8667·8	...	8887·2	520·8	
2 inches = 1 mile.	No. 2 Party, Khandesh and Bombay Native States	5" and 6" Theodolites.	824·8	1,221	·297	1·9	775	...	585·9	21	555	154·2	Amalner, Erandol, Chopra, Shirpur and Shahada of Khandesh.
	No. 6 Party, Sylhet	*	...	...	...	...	...	...	19·	*	...	...	Sylhet.
	Guzerat Party	6" and 10" Theodolites.	66·07	...	1·2	12·9	*	*	1,806	14·3	*	...	Baroda, Mahi Kanta, and Rewa Kanta.
	Kattywar Party	5" Theolite.	902.	2,348	1·0	13·4	*	2,348	2019·5	11·1	*	...	Sorath, Barda and Hallar of Kattywar.
			1792·87	3,569	...	...	775	2,348	4430·4	...	555	154·2	
4 inches = 1 mile.	Guzerat Party	6" Theodolite.	86·1	...	1·0	18·8	*	*	66·0	85·0	*	...	Dang States.
			86·1	...	...	...	...	...	66	...	...	...	
6 inches = 1 mile.	No. 1 Party, Chitorgarh Fortress	...	...	...	...	...	...	...	17·9	†	17·9	...	Chitorgarh Fortress and surrounding country.
	No. 7 Party, Simla and Kalka road, and other approaches ...	...	...	...	...	...	...	...	104·9	†	104·9	...	Road from Simla to Chandi, Dharampur to Subathu, Kasauli to Kalka, and Kasauli to Dharampur.
			...	...	...	...	...	...	122·8	...	121·9	...	
12 inches = 1 mile	No. 1 Party, Oodeypore City ...	...	...	...	...	...	...	...	6·7	†	...	...	Oodeypore City.
			...	...	...	...	...	...	6·7	...	...	...	
24 inches = 1 mile.	No. 7 Party, Kasauli and Subathu Cantonments	...	...	...	...	...	...	...	2·67	†	1·19	...	Kasauli and Subathu Cantonments.
			...	...	...	...	...	...	2·67	...	1·19	...	
1 inch = 1 mile.	No. 6 Party, North Brahmaputra Exploration	...	...	...	...	...	...	...	1,900	1·4	...	...	Chiefly in the Miri Hills.
	No. 7 Party, Rajputana ...	...	...	...	...	...	...	...	1,383	4·	2,118	*	Matani, Jodhpore and Bikaneer, Rajputana.
	Kumaon and Gurhwal Party ...	...	...	...	...	...	...	...	720	*	*	...	Gurhwal, Himalayas.
			...	...	...	...	...	...	4,003	...	2,118	...	
½ inch = 1 mile.	No. 6 Party, North Brahmaputra Exploration	...	...	...	...	...	...	...	2,080	1·4	2,480	...	Chiefly in the Mishmi Hills.
	Kumaon and Gurhwal Party ...	...	...	...	...	...	...	...	300	*	*	...	Gurhwal, Himalayas.
			...	...	...	...	...	...	2,389	...	2,480	...	
	Totals ...		1879·0	3,569	...	...	775	2,348	19,699	...	14,163	675	

* Not given.

† Very numerous, but not counted.

PART II.

THE OPERATIONS OF THE SURVEY PARTIES LATELY APPERTAINING TO THE REVENUE SURVEY DEPARTMENT, AND THOSE OF THE DEPUTY SURVEYOR GENERAL AND BOUNDARY COMMISSIONER'S OFFICES.

151. During the year under review, there were 11 full strength and 2* small parties at work in the following jurisdictions, *viz.*, 2 in the Punjab, 4 in the North-Western Provinces, 4 in Bengal, 2 in Bombay, and 1 in Assam.

Number of parties employed.

1st or Dera Ismail Khan and Bannu Districts	...	Punjab.
2nd or Sirsa District	...	
3rd or Saharanpur District	...	N. W. Provinces.
4th or Budaun District	...	
5th or Banda District	...	
6th or Jaunpur District	...	
7th or Khorda Estate, Pooree District	...	Bengal.
8th or Soane Irrigation Survey	...	
9th or Cuttack District	...	
* Chota Nagpore and Barkagarh Estates	...	
10th or North Deccan Topographical Survey	...	Bombay.
11th or South Deccan Topographical Survey	...	
* Lakhiraj Survey, Kamrup District	...	Assam.

Tabulated statements.

152. The area, cost, and rates of the season's out-turn, from 1st October 1877 to 30th September 1878, will be found in Table A, page 50. The *rates* for Districts Saharanpur and Cuttack are not given, as, owing to these surveys having been recently started, the rates would be fallacious and misleading. The work done in the Head-Quarters' Office, Drawing and Computing Branches, from 1st January to 31st December 1878, is given in Statement B. The principal records prepared in the several Executive Offices are tabulated in Statement C appended.

Nature and scale of survey.

153. The survey in the Punjab was, as hitherto, *mauzawar*, or village by village, on the scale of 4 inches to a mile, where, in addition to the village boundaries, all topographical features were surveyed and mapped with all the minuteness that the scale would admit of. In the North-Western Provinces, the survey of Banda and Jaunpur was cadastral, on the scale of 16 inches = 1 mile; while Budaun and Saharanpur were topographically surveyed on scales of 4 inches and 2 inches = 1 mile, respectively. In Budaun, village boundaries were surveyed, but in Saharanpur they were taken from the settlement maps, only pargana boundaries being surveyed professionally. To confine error in the fitting on of the settlement survey boundaries, the masonry platforms at the triple junction of villages were adopted as theodolite stations; the boundaries were carefully adjusted on these points and inserted by pantagraph on the 2-inch maps. In Bengal, the survey was cadastral on the scale of 32 inches = 1 mile, except in the Barkagarh and Chota Nagpur Estates, where it was conducted on the scales of 16 and 32 inches to a mile, according to the size of the fields. In the Deccan it was, as heretofore, topographical, on the scale of 2 inches to a mile. In Assam, the lakhiraj holdings were, as usual, surveyed on the scale of 8 inches to a mile, and recorded on the 4-inch maps of the former survey. This survey does not give any increase to the topographical area.

Out-turn

154. The total out-turn of the season amounts to 11,872 square miles of country surveyed in detail, on the various scales detailed in Table A, page 50.

In addition to the area surveyed in detail, 4,347 square miles were triangulated, and 6,906 square miles traversed in advance for season 1878-79.

155. The following comparative statement shows the results of this with the preceding season's operations :—

Comparison of results with previous year.

Scale of Survey.	1876-77.	1877-78.	Increase.	Decrease.	General reasons for increase or decrease.
Cadastral.	Sq. miles.	Sq. miles.	Sq. miles.	Sq. miles.	
16 inches = 1 mile ...	905	872	...	33	
32 „ = 1 „ ...	845	658	...	187	The decrease is due to the stoppage of work in Behar by one party, which has not been compensated for by the Cuttack outturn.
Mauzawar.					
4 inches = 1 mile ...	5,420	4,878	...	542	One party less than in 1876-77.
16 „ = 1 „ ...	...	57	57	...	
Topographical.					
1 inch = 1 mile	1,299	44	...	1,255	Decrease due to stoppage of one inch work on completion of Midnapur District.
2 inches = 1 mile	4,072	5,363	1,291	...	Increase due to employment of one extra party.
Civil Stations and Cantonments	4	...	...	4	None surveyed in 1877-78.
TOTAL ...	12,545	11,872	1,348	2,021	

156. Excluding Districts Saharanpur and Cuttack for the reasons stated in paragraph 152, the rates are as follow :—

Rates.

		Rs.	a.	p.
For 590 sq. ms. of Cadastral Survey, 32 inches = 1 mile,	@ per acre ...	0	10	5
„ 872 „ of „ „ 16 inches = 1 mile,	@ „ ...	0	6	2
„ 4,935 „ of Mauzawar or Village Survey, 4 inches = 1 mile,	@ per sq. m.	42	7	4
„ 4,513 „ of Topographical Survey, 2 inches = 1 mile	@ „	25	4	7

These rates show an increase over those of 1876-77 to the extent of 1 anna 6 pie per acre in the 32 inch Cadastral Survey, due to the smaller out-turn as compared with that of last year, during which an area of 712 square miles was surveyed by the Soane Irrigation parties at a low rate. There is also an increase of 1 anna 4 pie on the 16 inch Cadastral Survey, caused by the smaller out-turn during 1877-78, and the high rate for District Jaunpur in this its first season. The village 4 inches = 1 mile survey shows a decrease of Rs. 8-5-1 per square mile, notwithstanding that the area of 4,935 square miles for the season includes a small portion (57 square miles) of Bannu surveyed on the 16-inch scale. The topographical 2-inch survey shows a decrease of Rs. 2-4-11 per square mile.

157. The publication of the Cadastral maps has been strenuously pushed on, and the satisfactory results obtained during the year ending 31st December 1878 are given in the subjoined statement :—

Publication of Cadastral Maps.

Districts.	Number of Sheets.						Remarks.
	Surveyed.	Published in Surveyor General's Office.	Published by Lithograph at Allahabad.	Published by Calcutta Firms.	Total published up to 31st December 1878.	Remaining to be published on 31st December 1878.	
North-Western Provinces.							
Moradabad and Tarai ...	4,144	1,809	2,125	...	3,934	36(a)	(a) Exclusive of 174 sheets, not to be published, of re-surveys.
Muttra	1,663	1,218	1,018	...	2,236	2,059	
Banda	2,632	...					
Agra	3,024	937	...	...	947	2,077	
Hamirpur	2,952	2,626	...	...	2,626	326	
Azamgarh	930	930	...	...	930	...	
Jaunpur	270	...	...	...	...	270	
TOTAL ...	15,615	7,530	3,143	...	10,673	4,768	
Bengal.							
Shahabad	5,160	1,543	...	3,181	4,724	265(b)	(b) Exclusive of 171 sheets, not to be published.
Gya	3,085	270	...	2,686	2,956	129	
Patna							
Pooree, Khorda Estate ...	1,939	*Nil.*	*Nil.*	...	...	1,939	Survey in progress.
Cuttack	361	...	...	...	...	361	
TOTAL ...	10,545	1,813	...	5,867	7,680	2,694	
GRAND TOTAL ...	26,160	9,343	3,143	5,867	18,353	7,462	

158. Out of the 4,768 sheets of the North-Western Provinces which remain to be dealt with, embracing the results of surveys completed up to season 1877-78, 3,652 sheets will be printed at the Photographic Branch of the Surveyor-General's Office, and the remaining 1,116 sheets will be lithographed at Allahabad. The publication at the Photographic Branch proceeds at the rate of 80 sheets weekly, so that it will take about a year to clear off the sheets awaiting publication. Twenty-five copies of each sheet are printed, of which 22 are sent to Superintendent Government Press, Allahabad, and 3 copies are retained for record in this Office.

North-Western Provinces.

159. Considerable progress has been made in the publication of the Soane Irrigation maps. Tracings on transfer paper have been made and examined in the Head Office, and given out to the Firms of Messrs. Black, Sedgfield, and Chuckerbutty, for lithography. Proofs of all these maps have been carefully examined and passed by this Office before printing off. Out of 8,245 sheets of the Soane Irrigation Survey, 5,867 sheets (50 copies of each) have been printed by these Firms. The Photographic and Lithographic Branches of the Surveyor-General's Office have also been supplied with transfer traces, and have printed off (50 copies of each) 1,813 sheets, making a total of 7,680 sheets printed up to 31st December 1878. As, heretofore, 47 lithographic copies were forwarded, as soon as received from Press, to the Superintending Engineer, Soane Circle, 3 copies being retained for record. The Behar publications progress at the rate of 90 sheets weekly, and will thus be soon out of hand. The total number of Behar sheets unprinted, on 31st December 1878, amounted to 394, excluding the portion of the Shahabad District, which, the Superintending Engineer has recently intimated to the Deputy Superintendent of Survey, will not at present be irrigated. This tract extends over 171 sheets, of which lithographed maps will consequently not be immediately required.

Bengal.

160. During 1877-78, leveling operations were confined to Districts Banda and Budaun. The results are embodied in the following statement:—

Leveling.

	Banda.	Budaun.
Number of linear miles of levels	392	803
Number of bench marks fixed	258	495
Closing error per mile in feet	·0035	Not given.
Cost per linear mile	Rs. 8-5-5	Rs. 4-2-5

The level sections were run in parallel lines at right angles to the drainage of the country, and at a distance of 1½ miles apart in Banda and 1¾ miles in Budaun. The leveling in District Budaun has been completed, but owing to press of work during recess, in connection with the Moradabad District Leveling records, the closing errors for Budaun cannot yet be given.

161. This season it will be observed from paragraph 304, page 81, of the 11th Deccan Party, the topography of the Bombay Revenue (Settlement) Survey was utilised to some extent by Major Tanner, who is sanguine that he will be able to turn these maps to still better account as the work proceeds southwards.

Bombay Settlement Survey Maps.

162. The careful examination of the original Cadastral maps of the North-Western Provinces, according to the procedure noticed in paragraph 13 of my Introductory Report for last year, has been continued; and during 1878, 3,253 maps have been examined, cleared up, and rendered suitable for photography, and sent to Press. The proofs of 3,482 maps of the North-Western Provinces Cadastral Surveys have also been scrupulously examined in Office hours by European Assistants before passing the final Press

Examination of Cadastral Records.

order to print. Of the Soane Irrigation Survey, the proofs of 6,433 maps drawn on transfer paper by extra draftsmen out of office, and lithographed by contractors, have also been minutely compared with the originals (number by number) by the European Assistants; it was found necessary in many cases to examine second, and sometimes even third proofs, before Press order could be given, owing to defects in transfer.

The number of printed copies received from Press (*viz.*, 25 of each of the North-Western Provinces maps, and 50 each of the Behar Irrigation maps,) amounted during the year 1878 to 426,525 sheets. This enormous mass of records had all to be received, arranged, and despatched, by the Drawing Branch, as promptly as possible, after coloring 5 copies of each sheet for the North-Western Provinces Government, and 4 of each for Bengal. The number of sheets thus colored and examined during Office hours amounted to 44,877.

General maps and miscellaneous work.

163. The general work of the Drawing Branch, apart from that connected with Cadastral records and maps, is detailed in Table B, page 52, and shows a large out-turn of compilations and miscellaneous maps on various scales, as well as the number of proofs examined, the number of maps colored and examined for the India Office, for the Surveyor-General's Office, and for distribution to Government officials. This statement also shows abstracts of the miscellaneous maps, tracings, &c., prepared for Executive Officers and other officials; also the extra work done by contract out of Office hours for the public, but examined in Office, and the work performed in the Computing Branch.

Personnel.

164. With this Report my connection with the Department will terminate, as I retire from the service on the 31st December 1878, after a lengthened service in it of 32 years. I therefore desire to take this opportunity of prominently noticing the excellent service rendered uniformly by Mr. F. W. Kelly, the Head Assistant, Drawing Branch, who for 12 years has been attached to the Calcutta Office; likewise the good services of Messrs. J. P. Adels, W. Sinclair, A. Cunningham, Pemberton, Reilly, Connor, Lane, McHatton, and of Gopal Chunder Laha, Head Accountant, and Kalee Pudo Banerjee, Referential Clerk. Mr. Adels, Head Assistant, Correspondence Branch, is an old tried servant of Government and deserving of consideration.

Boundary Commissioner's Office.

165. The duties of the Boundary Commissioner's Office were performed by Major F. Coddington, Deputy Superintendent at Head-Quarters, and on his departure to England on six months' leave, by Captain S. H. Cowan, Assistant Superintendent, who officiated for him. On these two officers has likewise devolved the very heavy work connected with the Cadastral map publications. I am greatly indebted to both for their hearty co-operation and assistance.

PUNJAB.

I.—1st DIVISION, REVENUE BRANCH.

Dera Ismail Khan, Bannu, and Rawalpindi Districts.

166. The recess work of 1876-77 having as usual been punctually brought up by the 30th September 1877, this party, under the direction of Major-General H. C. Johnstone, C.B., took the field and resumed the survey of Districts Dera Ismail Khan, Bannu, and Rawalpindi early in October, closing work in the two former at the end of March, and in Rawalpindi at the end of June 1878.

Major-General H. C. Johnstone, C. B., Deputy Superintendent, 1st grade.

Assistants.

Captain R. Beavan, Officiating Assistant Superintendent, 1st grade.
Mr. G. Housden, Surveyor, 1st grade.
„ W. S. Buttress, Surveyor, 4th grade.
„ A. J. Gibson, „ „
„ G. B. Scott, „ „
„ R. Todd, Assistant Surveyor, 1st grade, transferred from Topographical Branch from 1st February 1878.
„ P. A. Peters, Assistant Surveyor, 4th grade.
27 Sub-Surveyors, &c.

Locality of survey.

167. In District *Dera Ismail Khan* the operations were confined to a boundary survey of villages in Pargana Bhakkar, Cis-Indus, covering 2,695 square miles.

In District *Bannu* the survey comprised 1,025 square miles of village boundary survey in Pargana Mianwali, and 202 square miles of triangulation over the Banghi Khel and Salt Ranges; while 1,153 square miles of Parganas Laki and Bannu were surveyed in detail, with an overlap of 50 square miles of topography surveyed without village boundaries on scale 4 inches = 1 mile in independent hill territory.

In District *Rawalpindi* the survey embraced the triangulation and detail survey of 404 square miles of the Murree and Kahuta Tahsils, in which the number of complete villages cannot be given at present, owing to the field sheets having been surveyed up to margin.

Jowaki country.

168. In addition to the area above detailed, Captain Beavan and Messrs. Scott and Gibson, who were ordered in December 1877 and January 1878 to join the expedition against the Jowaki tribe in the independent hill country between Peshawur and Kohat, succeeded in triangulating 350 square miles of country, of which 250 square miles were surveyed in detail on the scale of 4 inches to a mile. A brief report of the operations will be found in the appendix, to which attention is invited. I beg to bring the names of these officers to the favorable notice of Government. Captain Beavan, being employed for only a very brief period, was unable to do much; and where all three have done well, it is perhaps invidious to particularize; but Mr. Scott's services appear deserving of special commendation as a very intelligent, energetic, and zealous officer.

Total out-turn.

169. The results of the season's work represent an out-turn of 4,676 square miles of triangulation and village boundary survey, and 1,857 square miles finished in topographical detail, as shewn in the following abstract:—

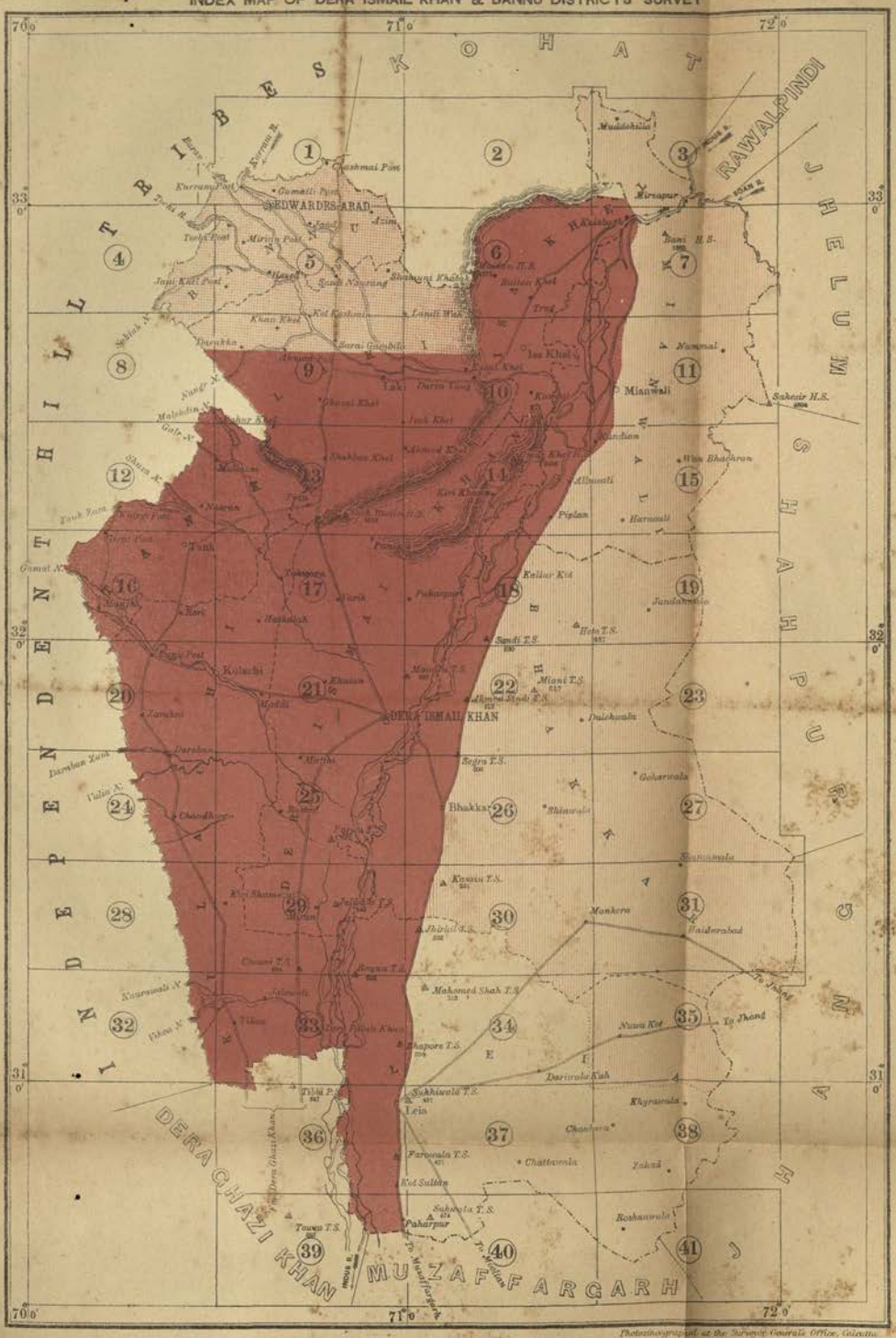
Districts.	Sub-divisions.	Area surveyed.	
		In detail.	Boundary.
Dera Ismail Khan	Pargana Bhakkar	.....	2,695v.
Bannu	„ Laki	1,153	.....
	„ Bannu		.....
	„ Mianwali	.....	1,025v.
	„ Isa Khel	.....	202t.
Independent hill territory (overlap)	.....	50	.....
Rawalpindi	Pargana Murree	404	404t.
	„ Kahuta	250	350t.
Jowaki country	.....		
	Total	1,857	4,676

In addition.

Note.—v stands for village survey; t for triangulation.

REVENUE BRANCH SURVEY OF INDIA

INDEX MAP OF DERA ISMAIL KHAN & BANNU DISTRICTS SURVEY


KOHAT
RAWALPINDI
JHELUM
SHAHPUR
SARGODHA
MIANWALI
BANNU
DERA ISMAIL KHAN
DERA GHAZI KHAN
MUZAFFARGARH
EDWARDES ABAD
Kashmai Pos
Kurram R.
Tochi R.
Tochi Post
Miryan Post
Jani Khel Post
Spina Narang
Shirkot Khel
Kot Kashmir
Lamiti Wam
Khan Khel
Darokha
Sarai Gambila
Bannu
Lakki
Duria Tang
Kurram R.
Sheral Khel
Jank Khel
Shakkas Khel
Ahmed Khel
Kot Khasora
Marwat
Nurana
Tank
Tank Zam
Gumal R.
Kulachi
Jandanwala
Haskalak
Mari
Fakargarh
Kallur Kot
Sandi T.S.
Hoto T.S.
Miani T.S.
Dulchawala
Daraban
Daraban Zam
Indus R.
Chandia
Zegra T.S.
Goharwala
Bhakkar
Shinawala
Kusuwa T.S.
Monkera
Haiderabad
Jhirlal T.S.
Mahomed Shah T.S.
Nawa Kot
Shapore T.S.
Darwala Kah
Sukhiwala T.S.
Leia
Tibba P.S.
Farooala T.S.
Chattawala
Kot Sultan
Sahowla T.S.
Paharpur
Toura T.S.
Kohawrwala
Jahand
Khyrawala
Chanbera
Monkera
Indus R.
Sutlej R.
Jhelum R.
Chenab R.
Ravi R.
Beas R.
Sohawa
Mundakhel
Hirapur
Jani H.S.
Nowmai
Sahsir H.S.
Wan Bhadaran
Piplan
Harnauli
Janjalwala
Sandhan
Khanwa
Kalamati
Kot Khasora
Jank Khel
Shakkas Khel
Ahmed Khel
Sheral Khel
Duria Tang
Lakki
Bannu
Darokha
Sarai Gambila
Khan Khel
Lamiti Wam
Kot Kashmir
Spina Narang
Shirkot Khel
Jani Khel Post
Tochi Post
Miryan Post
Kurram Post
Gumatti Post
Kashmai Post
Tochi R.
Kurram

170. The boundary survey in Dera Ismail Khan and Bannu, containing 145 villages and comprising an area of 3,922 square miles, has all been plotted on the scale of 4 inches to a mile ready in advance for detail survey.

Boundary survey in advance.

171. The area completed in detail, as above recorded, was surveyed on the scale of 4 inches to a mile, with the exception of 57 square miles in District Bannu, in the neighbourhood of Edwardesabad, which was done on the scale of 16 inches=1 mile. The large scale was employed, at the request of the Punjab Government, to shew the intricate system of irrigation. The detail survey of Bannu District was subjected to a careful test by running 90 linear miles of check survey through it. The Deputy Superintendent reports that—

Topography.

"the results were very satisfactory, and showed that the survey had been carefully made. The Sub-Surveyors were also frequently inspected in the field. In the Rawalpindi District the procedure was the same as that I adopted in Hazara; the plotted sheets were first given to the Sub-Surveyors to take out all the topographical detail, such as cultivation, drainage, village sites, &c., and then the assistants checked this work when surveying the hills."

172. The origin of survey for Districts Bannu and Dera Ismail Khan was, as in preceding season, an assumed point, *viz.*, the intersection of 31° 30′ north latitude and 71° east longitude. In the Rawalpindi District it was 33° 30′ north latitude and 73° east longitude. The rectangular co-ordinates of the various Great Trigonometrical Survey stations were calculated from origin; main circuit and other stations were connected with the triangulation, and the traverses corrected to agree with the Great Trigonometrical Survey data. The corrections applied through the work amounted to 2·17 links per 100 chains in latitude, and 1·04 links in departure. The direct distances tabulated below, taken from the Surveyors' figures, give good results:—

Connection with Great Trigonometrical Survey.

District.	Names of Great Trigonometrical Survey Stations.	Distances in Feet.		Error of Revenue Survey per mile.
		By Revenue Survey.	By Great Trigonometrical Survey.	
Dera Ismail Khan.	Sandi T. S. to Ahmad Sandi	51924·1	51895·8	+ 2·88
	Ahmad Sandi T. S. to Segra	47056·4	47040·2	+ 1·82
	Segra T. S. to Bakkar	46414·4	46424·9	— 1·19
	Bakkar T. S. to Kasain T. S.	61848·4	61851·4	— 0·25
	Sandi T. S. to Miani	56470·7	56501·5	— 2·88
	Miani T. S. to Heto T. S.	63206·1	63268·4	— 4·78
Bannu.	Bani H. S. to Mari H. S.	26259·0	26307·0	— 9·63
	Mari H. S. to Swas	79412·1	79418·2	— 0·40
		Average error $\left\{ \begin{matrix} + \\ - \end{matrix} \right\}$ =		2·44

173. The number of chains run in the course of the traverse survey amounted to 191,547, or 2,394 linear miles. The angular work was checked by 38 azimuth observations, and the mean average correction required was only 1 minute in 46 angles. Trijunctions of villages, which were all marked by masonry platforms, were used as theodolite stations.

Traverse survey.

174. Detailed areas of 382 villages have been furnished to the Settlement Officers of Bannu and Dera Ismail Khan. As far as the Settlement areas have been compared with those of the professional survey, the results have been satisfactory; but the percentage of difference cannot be reported on until the entire comparison has been completed.

Detail areas.

175. Major-General Johnstone remarks that—

Settlement maps.

"as a rule, the *thakbusts* or settlement boundary maps of Bannu and Dera Ismail Khan Districts were good, supplied in time, and agreed well with the professionally-surveyed boundaries; but

those of the hilly portions of the Rawalpindi District were, as might have been expected, somewhat indifferent."

Survey unobstructed.

176. It is satisfactory to note the Deputy Superintendent's statement that—

"there were no complaints against any of the survey party. There were difficulties on the Bannu frontier, but by tact they were surmounted. Our relations with the civil and military authorities, the Settlement Department, and all classes of the inhabitants in all the districts under survey, or through which we passed, were excellent throughout the year."

Murree sanitarium.

177. The work connected with the Jowaki survey interfered with the expected completion of the Murree sanitarium and maps. The survey, however, is all but done, and most of the maps have been drawn.

Personnel.

178. Of the members of his Establishment, the officer in charge writes:

"They have one and all upheld their reputation as good men and true."

Mr. Todd has proved himself a good Assistant. The native establishment, including the Hospital Assistant, has given complete satisfaction.

Future operations.

179. During 1878-79, the survey of the Murree and Kahuta Tahsils of District Rawalpindi will be continued. The Deputy Superintendent cannot give the area remaining for detail survey in this district till the traversing and triangulation are completed. In Mianwali Tahsil, of the Bannu District, there remains for detail survey an area of 1,025 square miles, of which the traverse survey has been already executed; also 202 square miles of the Banghi Khel hills already triangulated. In Dera Ismail Khan District, the traverse survey of the Bhakkar Tahsil has been done, comprising an area of 2,695 square miles; this has still to be surveyed in detail. There remains also the Leia Tahsil, which has not yet been touched.

Major-General Johnstone's retirement.

180. With this report closes the professional career of Major-General H. C. Johnstone, C.B., who retired on the 26th October 1877; his long and useful services in this Department extend over a period of 25 years, for 23 years of which he has held charge of a survey. That his services have been distinguished, is proved from the fact that he was made a Military Companion of the Most Honorable Order of the Bath. The Department loses in him a talented, able officer, and the Government a very tried, experienced servant, whom it will find difficult to replace in the Punjab, as his knowledge of the frontier, and of the tribes occupying it, rendered his services to the Government especially valuable.

II.—2ND DIVISION, REVENUE BRANCH.

SIRSA DISTRICT.

181. Captain E. H. Steel, Assistant Superintendent, with the establishment detailed in the margin, resumed the survey of District Sirsa of the Hissar Division early in October 1877. On the 19th November, Major D. Macdonald, Deputy Superintendent, relieved Captain Steel, who subsequently joined the Surveyor-General's Head-quarters' Office, Calcutta, in February 1878. Field work closed on the 1st April.

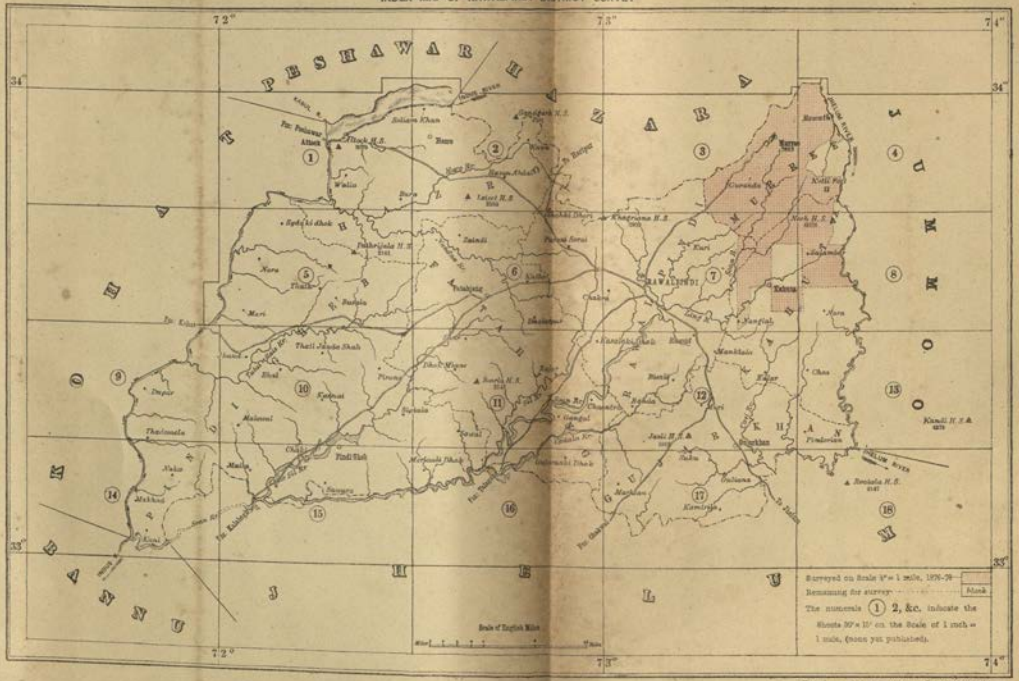
Major D. Macdonald, Deputy Superintendent, 2nd grade, from 19th November 1877.
Captain E. H. Steel, Assistant Superintendent, 2nd grade, in charge from 1st October to 18th November 1877, transferred to Surveyor General's Office from 1st February 1878.

Assistants.

Mr. E. Loftie, Surveyor, 2nd grade.
" G. H. Blyth, Surveyor, 2nd grade.
" J. S. Pemberton, Surveyor, 3rd grade, transferred to Head-quarters' Office, Calcutta, from 1st April 1878.
" P. Ford, Assistant Surveyor, 1st grade.
" B. Anderson, Assistant Surveyor, 2nd grade.
" C. S. Kaad, Assistant Surveyor, 4th grade.
35 Sub-Surveyors, &c.

REVENUE BRANCH SURVEY OF INDIA.

INDEX MAP OF RAWALPINDI DISTRICT SURVEY



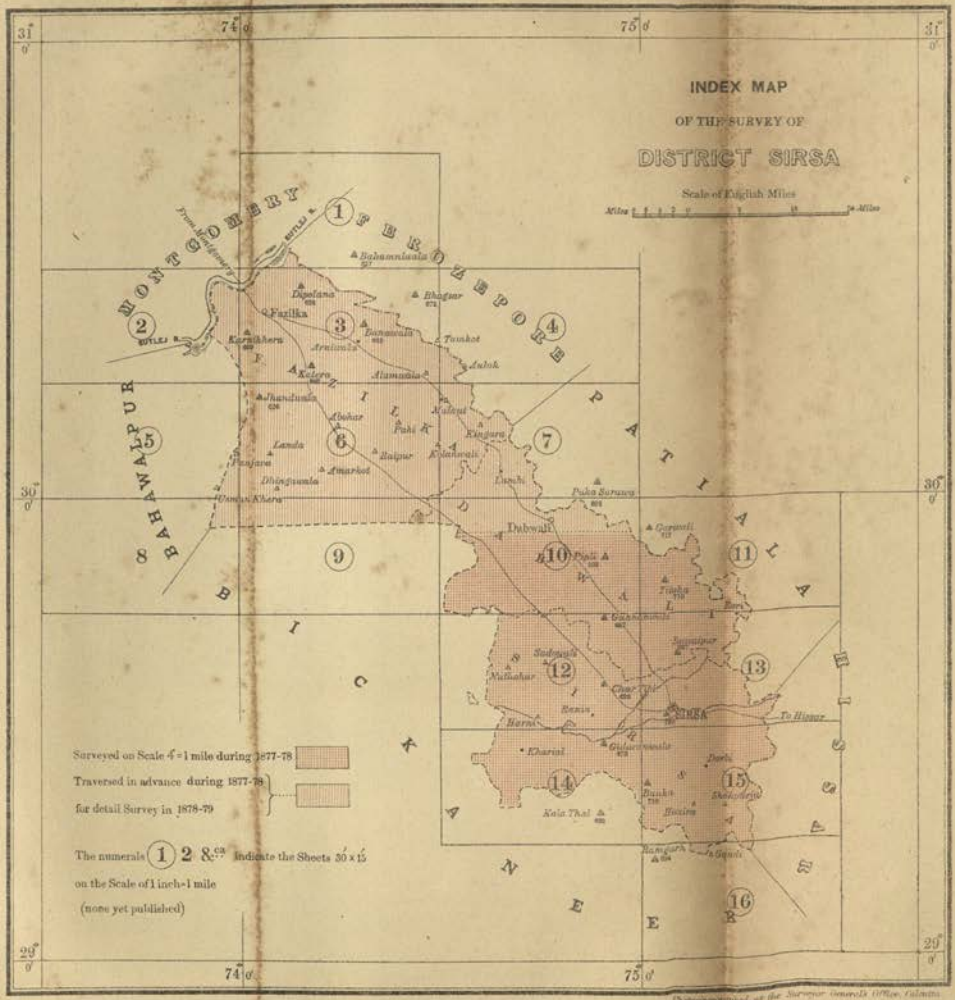
Published under the direction of Colonel J.T.Walker C.B. R.E. F.R.S. Surveyor General of India.

Surveyor General's Office Calcutta. February.

1879

Photozincographed at the Surveyor Generals Office Calcutta.

REVENUE BRANCH SURVEY OF INDIA


INDEX MAP
OF THE SURVEY OF
DISTRICT SIRSA
Scale of English Miles
Miles 0 1 2 3 4 5 10 Miles
MONTGOMERY
FEROZEPORE
BAHAWALPUR
PATIALA
BIKANER
JEIND
Surveyed on Scale 4 = 1 mile during 1877-78
Traversed in advance during 1877-78
for detail Survey in 1878-79
The numerals 1 2 &c. indicate the Sheets 30 x 15
on the Scale of 1 inch=1 mile
(none yet published)
SIRSA
To Hissar
Dubwali
Rania
Kalanwali
Jamalpur
Harnd
Kharial
Kala Thal
Rangarh
Sanala
Dhingsara
Amarkot
Lamba
Jhandwala
Dhanak Khera
Pakka Surawa
Gurnali
Tibbi
Chak Dhir
Bhangar
Bahamniwala
Dhalana
Fazilka
Tamkot
Aulok
Alamwala
Kalera
Kangura
Ghanghas
Sadowala
Mallahar
Bamu
Dhanda
Jhanjeri
Bhaini
Hasira
Shahdadpur
Dhanda
Kharia
Jhanjeri
Kharia
Kharia
Kharia

182. The district is divided into three Tahsils, Sirsa, Dubwali, and Fazilka, of which, Sirsa was surveyed in boundary during 1876-77. The work of the present season comprises the completion of the boundary survey of the two remaining tahsils, and the detail survey of the whole of Sirsa Tahsil, and greater portion of the Dubwali Tahsil, aggregating 1607·88 square miles, as tabulated below :—

Out-turn.

Tahsils.	Surveyed in Boundary.		Surveyed in detail.	
	Villages.	Square miles.	Villages.	Square miles.
Sirsa	202	993·47	202	993·47
Dubwali	158	807·16	115	614·41
Fazilka	299	1190·43	...	...
Total	659	2991·06	317	1607·88

In addition to this completed area within the limits of the district, an overlap of a mile in width and 186 square miles in area was surveyed, beyond the district boundary, in District Hissar and in the Patiala and Bikanir States, bringing up the total area surveyed topographically to 1,794 square miles, which represents an excellent out-turn.

183. The survey was made on the scale of 4 inches to a mile, the village being the unit of survey. All minute details usual on this scale were carefully surveyed and mapped; these details included cultivated, fallow, and culturable land, village boundaries and sites, markets, roads, paths, buildings, &c. Sirsa District is described as, on the whole, an easy country to survey, but—

Scale and description of survey.

"near the Gaggar and other rivers, subject to inundation, the details of cultivation, &c., are very intricate and required very careful surveying. Another obstacle to rapid progress in well-cultivated parts is the drifting sand, which pervades the whole district and obliterates the land-marks. It is often very difficult to say where the cultivation ends, and the Surveyor is in a great measure dependent on the villagers for this information. Portions of Sirsa, which, to an ordinary traveller, would appear nothing but a sandy waste, is often a mass of cultivation. The barley, one of the principal *rabi* crops, may be seen all over the district forcing its way up through several inches of drift sand."

In the overlap alluded to, no details of cultivation were surveyed outside the district boundary; but rivers, streams, village sites, roads, canals, temples, wells, everything in fact of a permanent nature, was mapped.

184. The accuracy of the detail survey was tested by 525 linear miles of check survey, and the results are pronounced by the Deputy Superintendent to be most satisfactory in every respect. Besides running these check lines of survey across the plane-tables, the Sub-Surveyors were constantly visited in the field, and their work inspected and tested *in situ* by the Deputy Superintendent and his Assistants.

Check survey.

185. The origin of survey for Sirsa District is the point of intersection of parallel 30° north latitude and meridian 74°30' east longitude, which falls about the centre of the district. Every traverse station, whether in the main circuit, sub-divisional, or village polygon, has been referred to the origin, and all stations common to each traverse have one and the same value, indicated by the co-ordinates from origin of survey.

Origin of survey.

186. The Deputy Superintendent reports that the traverse survey was connected with the principal and secondary stations of the Great Trigonometrical Survey wherever they could be identified. The rectangular co-ordinates of these stations had been previously computed from the origin of survey, and the Revenue Survey traverses were corrected and made to accord with the Great Trigonometrical Survey values.

Connection with Great Trigonometrical Survey.

Nine principal and ten secondary stations of the Great Trigonometrical Survey were connected by traverse and incorporated in the season's work. The average correction applied to main circuit traverses amounts to 0·92 of a link in

every 100 chains of meridian, and 0·85 of a link in every 100 chains of departure; but to shew the traverse error with reference to Great Trigonometrical Survey values, the Deputy Superintendent has tabulated the results of a comparison of fifteen direct distances in feet between the stations of the Garhagarh and Sutlej Series and those obtained by the uncorrected traverses of the Revenue Survey; they are as follow:—

From	To	Distances in feet.		Revenue Survey error per mile.	
		Revenue Survey.	Great Trigonometrical Survey.	+	−
Gukhawali	Tiloka	56685·2	56679·8	0·50	...
Sawaipur	Ditto	60097·0	60095·2	0·16	...
Gukhawali	Pipli	47063·2	47063·7	...	0·02
Tiloka	Ditto	51606·2	51593·0	1·35	...
Pipli	Garwali	42962·8	42971·1	...	1·02
Tiloka	Ditto	43137·5	43138·0	...	0·06
Garwali	Paka Sarawa	55203·4	55194·7	0·83	...
Pipli	Ditto	59467·8	59473·2	...	0·48
Karni Khera	Jhandwala	52146·0	52188·4	...	4·29
Ditto	Katera	57283·1	57267·4	1·45	...
Jhandwala	Ditto	48448·8	48439·2	1·04	...
Karni Khera	Dipolana	55614·7	55662·3	...	4·51
Katera	Ditto	63366·4	63357·4	0·75	...
Dipolana	Banawala	57402·0	57400·4	0·15	...
Katera	Ditto	53325·2	53316·8	0·83	...
	Average Revenue Survey error			0·78	1·73
	General average error $\{\pm\}$			1·16	

The results are very good, except in two cases, where the large differences are due to the broken ground near the Sutlej River, along which the chain lines were run.

Traverse Survey.

187. The angular work has been tested by 31 azimuth observations taken at an average distance of 13 miles along the main circuits. The average angular correction amounts to 1 minute in every 29 angles.

The distance chained in the course of the traverse measurements amounts to 2,723 miles.

Demarcation.

188. The demarcation of boundaries was very good. There was delay at first in receiving the settlement boundary or *hadbast* maps, but before leaving the field, nearly the whole of these had been supplied. They are said to be excellent maps, and the few discrepancies that appeared on comparison with the survey boundaries were readily adjusted.

Personnel.

189. Major Macdonald expresses himself well pleased with the exertions of his party. He also acknowledges the cordial assistance rendered by the Deputy Commissioner and other district officials.

Future work.

190. To complete District Sirsa, there now remain 342 villages covering 1,383 square miles, comprising a portion of the Dubwali and the whole of Fazilka Tahsil (of which the boundary survey has already been done), and that portion of the

Sutlej River forming the northern boundary of the district. The survey will be brought to a close during 1878-79, and work will also be started this season in District Jhelum under orders of Government, quoted in the margin. The survey will be mouzawar on the scale of 4 inches = 1 mile, in aid of settlement operations, and excluding topographical details, the Districts having already been surveyed topographically.

No. $\frac{S}{103C.}$ dated 18th September 1878, from Secretary to Financial Commissioner, Punjab.

191. This party was inspected by me at Landour in September, and I found everything in good order. Major Macdonald is an officer of excellent business-like habits, and methodical. I found both his maps and calculations nearly completed. He is very careful and attentive to his duties, and it is a pleasure to inspect such a well-ordered office.

Inspection of party.

NORTH-WESTERN PROVINCES.

III.—3RD DIVISION, REVENUE BRANCH.

SAHARANPUR DISTRICT.

192. The 14th or Ganges Dearah Survey, on completing its assigned work in Bengal, was transferred to the North-Western Provinces, under orders* of the Supreme Government, for the survey of District Saharanpur, as stated in paragraph 144 of last report.

* No. 721, dated 8th December 1877, to North-Western Provinces Government.

193. The party, constituted as shewn in the margin, left its recess quarters at Barrackpur in December 1877, under the conduct of Major Wilkins, and commenced work on the 24th of that month at Saharanpur, where it was strengthened by the addition of Captain Lees Smith and Mr. J. Todd. Field work closed about the middle of May.

Commencement and close of work.

ESTABLISHMENT.

Major W. H. Wilkins, Deputy Superintendent, 3rd grade.

Assistants.

Captain H. L. Smith, Assistant Superintendent, 1st grade, returned from furlough and resumed duty on the afternoon of 9th January 1878.
Mr. J. Todd, Surveyor, 3rd grade, transferred from Midnapur Survey from 1st January 1878.
" R. C. D. Ewing, Assistant Surveyor, 1st grade.
" C. W. Wilson " " 3rd "
" C. W. F. Seyers " " 3rd "
20 Sub-Surveyors, &c.

194. District Saharanpur is situated between the parallels of $\frac{29° 35'}{30° 20'}$ north latitude, and meridians $\frac{77° 07'}{78° 16'}$ east longitude. It is bounded on the north by the Siwalik Hills, which separate it from District Dehra Dún; on the east by the Ganges and District Bijnaur; on the west by the Jumna, beyond which lie Districts Karnal and Amballa of the Punjab; on the south by District Muzaffarnagar.

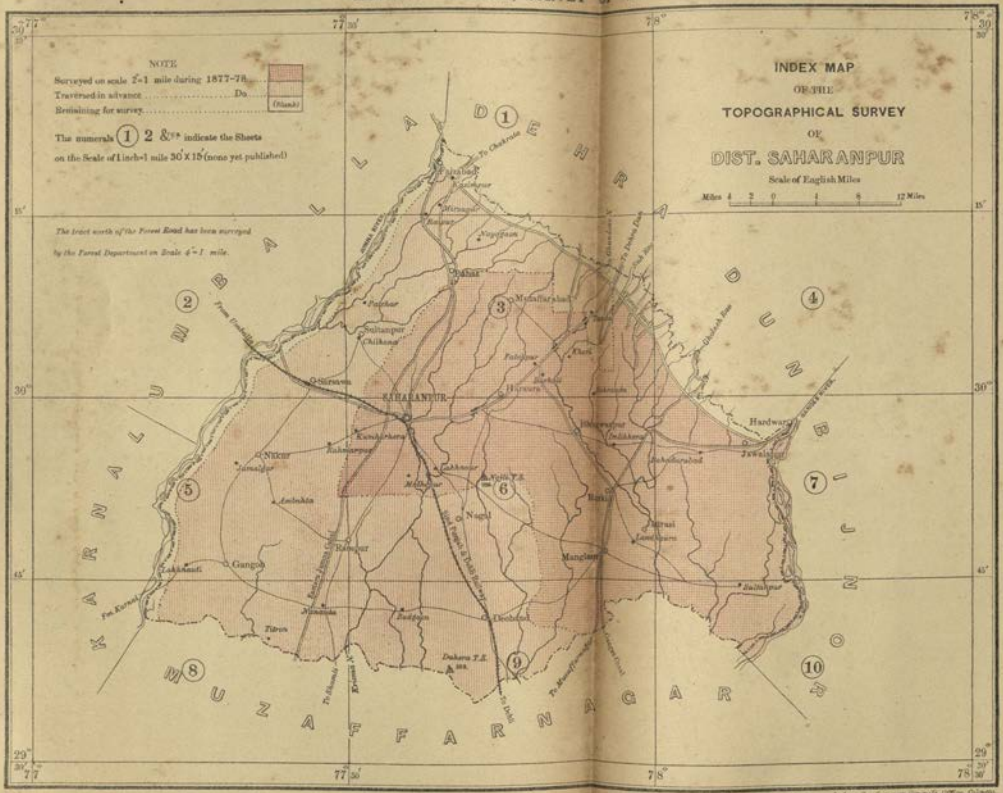
Locality of survey.

195. It was decided by Government that the re-survey of District Saharanpur, in common with the other districts of the North-Western Provinces, of which only topographical maps are needed, should be conducted on the scale of 2 inches to a mile, shewing, in addition to the topography, the pargana (fiscal) and thana (police) boundaries. Subsequently it was ruled that, as thana boundaries were liable to constant changes, they should not be surveyed and mapped. The Board of Revenue having reported that the triple junctions of village boundaries were permanently marked by masonry platforms, it was directed that they should be made theodolite stations of the traverse survey whenever practicable, and that the village boundaries should be inserted from the settlement maps or from those saved of Captain Brown's survey of 1833-36, and fitted into these numerous fixed points. Full and clear instructions were accordingly conveyed to Major Wilkins that, as the survey was for topographical purposes only, and not as a check on settlement operations, it would be unnecessary to crowd into the interior survey minute details of cultivation, culturable, waste, or jungle lands, and all that was needed was a good topographical delineation of the country up to scale of survey, *i. e.*, that the survey should include large patches of waste, barren as well as culturable; the general outlines of cultivation, tracts of jungle, limits of forest reserves; roads, drainage in all its ramifications, tanks, village sites, temples, embankments, &c. In short, the same details that are required in the usual village-by-village 4 inch = 1 mile survey, but *generalized*.

Character and scale of survey.

196. The traverse survey executed with theodolite and chain, and connected with the Great Trigonometrical Survey stations of the Great Arc Series, embraces an area of 1,750 square miles. Of this 850 square miles were completed in detail. The detail survey extended to Parganas Rurki, Bhagwanpur,

Extent of survey.



Published under the direction of Colonel J.T. Walker C.B. R.E. F.R.S. Surveyor General of India.
Surveyor General's Office. Calcutta. January
1879

Photozincographed at the Surveyor Generals Office, Calcutta.

Manglaur, and Jowalapur of the Rurki Tahsil, and to Parganas Haraura, Saharanpur and Muzaffarabad of the Saharanpur Tahsil.

Forest survey.

197. The Government forest lands having been elaborately surveyed by the Forest Survey Branch, on the scale of 4 inches to a mile, from the Siwaliks to the forest road traversing the district east and west along the base of the hills from the Ganges to the Jumna, there was no necessity for going over this ground again. The Topographical Survey has been carried up to the forest road, along which the details of the two surveys have been compared and reported by Major Wilkins to agree very well, except in a few places, which will be proved during the present field season. The forest lands, having been demarcated by masonry pillars, offered numerous points of reference, by means of which a good connection was effected.

Detail survey.

198. Major Wilkins and his European Assistants carefully tested the plane-table sheets of the Sub-Surveyors by 317 linear miles of check survey; the interior survey was found to have been well and carefully done.

Demarcation.

199. All trijunction platforms are reported to have been taken up and adopted as theodolite stations wherever they could be found. In the majority of cases the old platforms were in existence, though many were out of repair; but the Collector received orders from the Board of Revenue to repair all old platforms, and to build them where none existed. This work was carried on during the cold weather and is now completed. It is, however, very desirable that the building and repairing of platforms should be carried on ahead of the survey, and not after it, as it is otherwise impossible to tell whether the platforms are built exactly over the survey stations or not. The state of the platforms as found at the time of survey has been recorded in the field books of the traverse survey.

Village boundaries.

200. Major Wilkins states that the village boundaries reduced from the Settlement maps and those of the old (4 inch = 1 mile) Revenue Survey agreed fairly well as a rule, but near rivers the boundaries could not be reconciled; in other cases the Settlement maps did not agree *inter se* or with the old Revenue Survey. These discrepancies will be referred, during this field season, to the Collector.

Amount of chaining.

201. The number of chains run in the course of the traverse survey of main circuits amounted to 604 linear miles, and in the village survey to 2,278 linear miles. Main circuits were made conterminous with pargana limits.

Connection with Great Trigonometrical Survey.

202. The traverse survey was connected with four principal and nine minor stations of the Great Arc Series.* All traverse co-ordinate values have been corrected to agree with Great Trigonometrical Survey data. There are numerous secondary points of the Great Arc Series within or adjacent to the Saharanpur District; but it is not surprising that, after the lapse of 50 years, the Surveyor was unable to identify more. The origin of survey for the district is an assumed point at the intersection of latitude 29° 45′ north and longitude 77° 45′ east, to which all the co-ordinates and azimuth observations are referred. Endeavors were made to use the azimuths of the sides of the principal triangles after applying convergency to check the angular work, but it was found impossible to do so, as the flash of the heliotrope could not be seen between the stations—

* Chandipahar	Principal	H. S.
Dahera	Principal	T. S.
Godhna	Principal	T. S.
Nojli	Principal	T. S.
Alhanpur		S.
Damjhera		S.
Ibrahimpur		S.
Kotra		S.
Lakhnauti		S.
Ghansgarh		Mosque
Palana		S.
Rurki		S.
Shahpur		S.

"the probable reason being that the view was intercepted by trees that have grown up during the 50 years which have elapsed since the Great Trigonometrical Survey observations were made."

To compensate, however, for the Great Trigonometrical Survey azimuths not being used, the angular work was rigorously checked by sixty-eight observations for azimuth.

The four principal stations above noted are all in good repair.

Mapping.

203. The final maps of Saharanpur District (of which the present season's work comprises ten) will include twenty-four sheets, drawn on gratigule 7½′ latitude by 15′ longitude, scale 2 inches to a mile. Four of these will be put together and reduced by photography to form 1-inch standard sheets, measuring 15′ latitude by 30′ longitude. Manuscript copies of the 2-inch = 1 mile maps for the Collector of the district are being made up of complete parganas; these will number fifteen, of which seven fall within the season's work. The mapping is complete in all respects, except as regards the village boundaries before alluded to, and which will be adjusted during 1878-79.

Programme for 1878-79.

204. During 1878-79 the area of 900 square miles, which has already been traversed, will be completed in detail. There also remains for survey in boundary and interior a strip of country skirting the Jumna, containing an area of about 100 square miles. The total area of Saharanpur is 2,228 square miles; of this 850 have been completed, and about 1,000 remain to be done. The tract taken up by the Forest Survey has an area of about 378 square miles. Major Wilkins' party will also, during this season, proceed with the survey of District Muzaffarnagar, adjoining Saharanpur on the south. The area of Muzaffarnagar by the former survey of 1836 is 1,647 square miles.

Personnel.

205. Major Wilkins reports well of the exertions of his Assistants, specially mentioning Captain H. Lees Smith, Assistant Superintendent, and Messrs. Todd and Ewing. The Sub-Surveyors also, with few exceptions, did good service.

Inspection of party.

206. During my tour of inspection in September, Major Wilkins' office, which was located at Mussoorce, was visited, and his work examined. I was satisfied that both during the field and recess seasons care and attention had been bestowed on his duties. Major Wilkins thoroughly understands his work.

IV.—4TH DIVISION, REVENUE BRANCH.

DISTRICT BUDAUN.

Field operations resumed.

207. This party has continued during the year under the charge of Captain W. Barron. The recess duties of 1876-77 were brought to a close on the 7th November 1877. Field operations were commenced in District Budaun on the 19th idem, the survey of District Moradabad having been completed as noted in paragraph 40 of last report.

ESTABLISHMENT.

Captain W. Barron, Deputy Superintendent, 3rd grade.

Assistants.

Captain A. J. Corse-Scott, Officiating Assistant Superintendent, 2nd grade.
Mr. W. Sinclair, Surveyor, 2nd grade, transferred to Head-quarters' Office, Calcutta, from 23rd October 1877.
„ W. A. Wilson, Surveyor, 3rd grade, transferred from the late Ganges Dearah Survey from 1st October 1877.
„ H. T. Hanby, Surveyor, 4th grade.
„ S. O. Madras, Assistant Surveyor, 2nd grade.
„ W. D. Corbett, Assistant Surveyor, 3rd grade, transferred from Chota Nagpur Estate Survey from 1st November 1877.
„ J. Murphy, Assistant Surveyor, 3rd grade, transferred from 5th Division Survey from 1st October 1877.
„ C. W. J. Ford, Assistant Surveyor, 4th grade, transferred to 12th Division Survey from 1st November 1877.
„ E. P. S. Hill, Assistant Surveyor, 4th grade, transferred to 5th Division Survey from 1st October 1877.
„ L. F. Berkeley, Assistant Surveyor, 4th grade.
„ W. H. D. Ewing, Probationary Assistant Surveyor, appointed from 15th April 1878.

32 Sub-Surveyors, &c.

Leveling Party.

Mr. W. J. Lincoln, Assistant Surveyor, 2nd grade.
„ C. B. Taylor, Office Assistant.

The delay in taking the field was due to references on the subject referred to in paragraph 42 of previous report.

The survey of Budaun being merely for topographical purposes, the scale fixed was that of 4 inches to a mile, taking up all village boundaries, topographical items, limits of

cultivation, fallow, &c., as far as the scale admitted, being in fact what has hitherto been known as a "mouzawar" or village survey.

Season's out-turn.

208. In paragraph 40 of last year's report, reference was made to the maps and records that awaited completion. To bring up these, it was found desirable to employ about one-half of the establishment throughout the whole year solely on this work. Notwithstanding this, an area of 1110·05 square miles has been completed by the remainder, including 218 square miles of river and overlap survey, completing the topography of District Budaun. This area was divided, for convenience of survey, into 1,346 traverse blocks, entailing the observation of 3,722 angles and the measurement of 877 miles of chaining. The average size of each block was 511·8 acres. Field operations were continued till the middle of April last, when the party returned to Naini Tal to recess quarters.

Check and verification of work.

209. The angular work was checked by azimuths, one being observed for every 25 angles, or at an average distance of 7·6 miles apart.

The origin of survey was that stated in paragraph 39 of last report—"Sarsotha, G. T. S." The co-ordinates of all traversed stations have been referred to this point: thus, every station has but one value, and the total area of the contained blocks necessarily agrees with that of the main circuit area.

The topographical details have been verified by the measurement of 301 miles of check survey, executed by the European Assistants.

Recess duties.

210. In addition to the bringing up of the past season's records, great progress has been made in completing the cadastral maps and records of former seasons. These are now so well advanced, that there is every prospect of their being finally lodged during January 1879: 2,161 maps were traced on prepared paper for transfer and publication by lithography, and made over to the Revenue Board, North-Western Provinces, to print.

Permanent marks.

211. The trijunction points of villages being marked by masonry platforms, they have in all cases been adopted as theodolite stations. In addition 2,156 theodolite stations have been marked by the embedding of baked clay cylinders, which latter will, if not disturbed, last for some years to come.

Operations in prospect.

112. The allotment of a new district for this establishment has been for some time under discussion. It is now finally settled that the District of Ghazipur shall be surveyed cadastrally. Consequently, on resuming field operations, a beginning will be made by taking up the boundary survey of villages. During the coming season a probable area of 500 square miles will be completed in traverse survey, and, as soon as the Moradabad District records are got rid of, the cadastral measurements will be commenced, and as large an area as is found to be possible will be completed before the field season closes. Owing to changes in boundary, caused by the Rivers Ganges and Ram Gunga, the limits of the district remained in uncertainty; the Government of the North-Western Provinces has recently decided that the main mid-stream shall be taken as the limit up to which the district boundary shall be carried. The survey will now be able to close work, and to complete the areas and records of District Budaun.

Personnel.

113. Captain Barron reports that all under him have worked well, and with zeal and energy. It is greatly to the credit of all concerned that, with but half his establishment at field work, an area of over 1,100 square miles has been completed.

Captain A. J. Corse-Scott, Assistant Superintendent, is reported to have conducted his duties with ability and success. It is to be regretted that his close application to work has injuriously affected his eyesight, so as to compel him to seek medical advice, and, as rest has been recommended, he has been granted two months' leave.

Mr. Hanby's exertions throughout the year are brought to notice.

The other Assistants are all favorably noticed. Mr. Ewing joined this establishment on the 15th April last, on first appointment to the Department; he is said to promise well and to take interest in his work.

Publication of maps.

214. The Photographic Branch of the Surveyor General's Office being unable to cope with the reproduction of the many hundreds of cadastral maps that have been accumulating during the past five years, and since they were urgently required, it became necessary to apply for assistance elsewhere. Accordingly, the Board of Revenue, North-Western Provinces, were addressed, and readily consented to take up some portion of the large arrears, and to print the maps at the Government Press at Allahabad, provided they were furnished with transfer traces. Captain Barron was accordingly directed to commence tracing the maps of District Moradabad, of which there were 2,161 appertaining to 1,809 villages awaiting publication. On the 30th September all but 36 sheets had been sent to press; these were necessarily detained on account of changes required by the Settlement Department. The cost of the traces has been Rs. 6,244-14-10. Great credit is due to Captain Barron for the expeditious manner in which he was able to get this work out of hand, as a special staff had to be raised for the purpose.

Eight hundred and eighty-two sheets of Pargana Hassanpur have also been published as surveyed, without awaiting the examination and omission lists hitherto sent in by the Settlement Officers; this procedure is sanctioned by the Board of Revenue, North-Western Provinces, for the future.

Captain Barron's arrears will be worked off by January, so that he will be able to commence the survey of Ghazipur District unhampered. It will be interesting to watch his future progress, and to note if all arrears can be kept down.

Leveling.

215. Mr. C. B. Taylor, Office Assistant, and Mr. W. J. Lincoln, Assistant Surveyor, have been employed in running the lines of levels determined for District Budaun; these have been all completed; the heights of 495 bench-marks have been determined and marked; 5,345 stations were made, extending over a distance of 803 miles. The sections were run in parallel lines at right angles to the drainage of the district at about $1\frac{3}{4}$ miles apart.

The total cost has been Rs. 3,333-3-2. The daily average out-turn and rate of progress was 3·8 miles per day.

Owing to the necessity of keeping the leveling party engaged during the recess months in inserting the level lines and heights on the 4-inch sheets of District Moradabad, the closing errors of the sections of the past season in Budaun have not yet been ascertained. The sheets of Moradabad have all been completed, and the work of the Budaun District is now in hand.

Inspection.

216. This party was inspected by me in October, and Captain Barron, as usual, was ever ready to afford the fullest explanation on all points connected with his work. He is a most intelligent and valuable officer. He thoroughly understands his duties, and sees that the Assistants perform theirs.

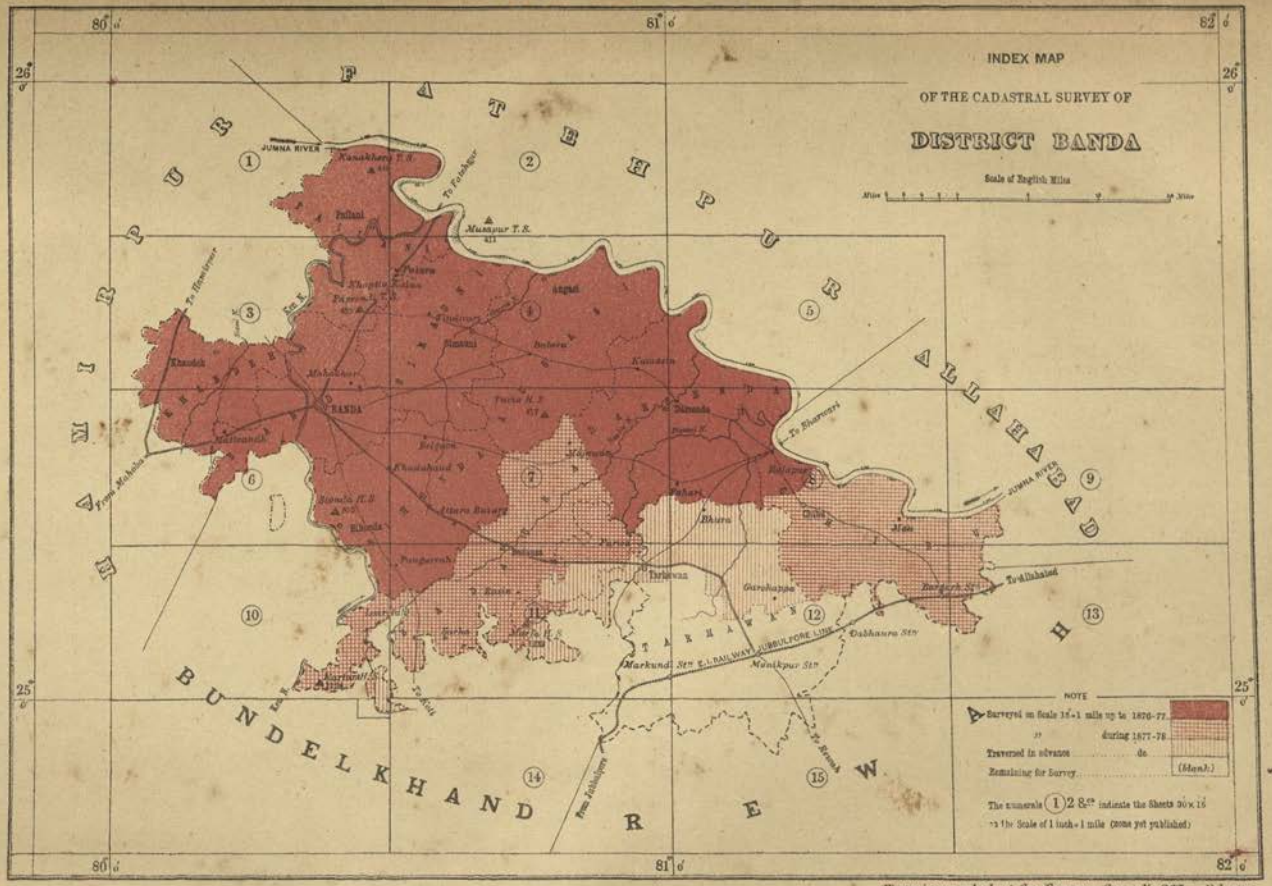
V.—5TH DIVISION, REVENUE BRANCH.

BANDA DISTRICT.

Renewal of operations.

217. The charge of this party has remained throughout the year under Colonel Anderson. The previous recess operations having been brought to a close

REVENUE BRANCH SURVEY OF INDIA


INDEX MAP
OF THE CADASTRAL SURVEY OF
DISTRICT BANDA
Scale of English Miles
NOTE
Surveyed on Scale 16 = 1 mile up to 1876-77
" during 1877-78
Traversed in advance do.
Remaining for Survey (Blank.)
The numerals (1) 2 &c. indicate the Sheets 30 x 16
of the Scale of 1 inch = 1 mile (none yet published)
BUNDELKHAND
ALLAHABAD
JUMNA RIVER
BANDA
Markundi Stn
Manikpur Stn
Dabhaura Stn
Tarahaula
Karwi
Rajapur
Mau
Pahari
Baberu
Naraini
Kamasin
Jigni
Pailani
Kalinjar
Kirwee
Mahoba
Charkhari
Chhatarpur
Panna
Ajaigarh
Kalinger
Punnah
Gurehajpur
Bharra
Gurra
Atra
Tindwari
Jobhat
Kabrai
Jaitpur
Kulpahar
Kunch
Kalpee
Jalaun
Orai
Kotra
Kuthond
Kurara
Kabrai
Mahoba
Khandeh
Kulpahar
Kalpee
Kunch
Orai
Jalaun
Kotra
Kurara
Kuthond

on the 23rd October 1877, field measurements were resumed in District Banda on the 1st November, with a strength of establishment as per margin. The cadastral survey of Parganas Badausa and Chibu were continued under the same system as that carried out during the past five years, which may be briefly described as follows. A traverse survey is carried on in advance of the cadastral measurements, a sufficiency of points being thus obtained for the filling in of the details and field limits; on these plotted points as a basis, the field surveyors (amins) form their intermediate triangles, plotting their field sketch books roughly on the double scale. Simultaneously the amin also plots the cadastral sheets *in situ*; a certain amount of the plotting of each sheet is subsequently tested in office by plots made direct from the field books. Colonel Anderson is of opinion that the plotting done in this manner is "much cheaper and quite as correct" as plotting done solely from the field books; this is possibly the case, but the cost saved does not in any way compensate for the possible shortcomings that may exist in all field books that are not strictly made use of as the real basis of the maps. Their value as records is consequently considerably lessened.

ESTABLISHMENT.

Colonel F. C. Anderson, Deputy Superintentent, 1st grade.

Assistants.

Mr. E. J. Jackson, Assistant Superintendent, 2nd grade.
„ C. W. Campbell, Surveyor, 2nd grade.
„ E. Little, Surveyor, 4th grade.
„ R. B. Smart, Jr., Assistant Surveyor, 1st grade.
„ G. W. Jarbo, Assistant Surveyor, 2nd grade.
„ J. R. Scott, Assistant Surveyor, 2nd grade, transferred to 12th Division from 1st November 1877.
„ T. F. Freeman, Assistant Surveyor, 2nd grade.
„ J. Murphy, Assistant Surveyor, 3rd grade, transferred to 4th Division from 1st October 1877.
„ H. G. Young, Assistant Surveyor, 3rd grade.
„ P. C. H. Smart, Probationary Assistant Surveyor, 4th grade, appointed from 18th April 1878.
26 Sub-Surveyors, &c.

Leveling Party.

Mr. E. P. S. Hill, Assistant Surveyor, 3rd grade, transferred to 4th Division from 1st October 1877.

218. The season's out-turn has resulted in the final completion of 725 square miles of country, 606·4 square miles being cadastrally surveyed on the 16-inch scale, and 119 topographically on the 4 inch scale, as detailed in the following statement:—

Season's out-turn.

PARGANAS.	Villages.	Fields.	Acres.	Square miles.	Average size of fields in acres.
16-inch scale.					
Chibu	152	149,273	164233·60	256·61	1·10
Badausa	146	219,341	218108·95	340·80	0·99
River Jumna, left bank	.....	.....	5760·0	9·0	.....
TOTAL	298	368,614	388102·55	606·41	1·05
4-inch scale.					
		Blocks.			
Rewah territory	.....	36	23130·0	36·14	.....
Independent territory	14	56	53053·95	82·90	.....
TOTAL	...	92	76183·95	119·04	.....

219. In the execution of the traverse survey, 9,419 angles were observed, and 2,327 miles of chaining effected. In twenty villages of about the average size, and with average-sized fields, the average chaining executed amounts to 13·36 chains per acre. In the cadastral measurements 64,813 running miles have been measured, exclusive of the traverse survey.

Average of chaining.

200. As a check on the angular work, eleven azimuths were observed. To close the main circuit traverses a correction of only 1·7 links in latitude and of 1·6 links in departure per 100 chains has been applied. All meridians have been referred to that of the origin, "Pavia G. T. S." One additional Great Trigonometrical Survey station, "Kartal" fell within the season's

Check and verification of work.

operations. This was connected on. The following table shews the relative direct distances in feet and error per mile:—

Names of Stations.	Direct distance by		Total difference.	Error per mile.
	Great Trigonometrical Survey.	Revenue Survey.		
From Sikonda to Kartal	101254·9	101252·5	— 24	—0·1
„ Marfa to Kartal	125055·7	125097·1	+41·4	+1·7

The direct distance by Revenue Survey has been computed from the corrected co-ordinates of the main circuit traverses; these latter have not been corrected to agree with the Great Trigonometrical Survey values, which would have been more desirable.

To verify the internal measurements, the native inspectors measured 2,963 check lines, or a distance of 1,220 miles. The European officers measured 610 lines, aggregating 238 miles. No field plan was finally accepted until passed by one of the European Assistants after comparison with the check survey.

Close of field season.

221. The field operations were brought to a close on the 13th April 1878, when the party returned for recess duties to Naini Tal, where the mapping and computations were commenced on the 22nd idem. The duration of the field season was 5½ months.

Records prepared.

222. The first work attended to during recess was the completion of the maps and records of such portions of the Banda District as were immediately required by the two Settlement Officers. To this end, during the recess, traces of 705 cadastral sheets and 333 khasra volumes, appertaining to the measurements to the past season, were completed and made over. As far as found practicable, the records of the area surveyed prior to October 1877 received attention; great progress has been made towards their completion; unfortunately a vast number had been allowed to accumulate owing to the system of "Badar" lists.

All the records of Muttra District have now been lodged, with exception of those of Pargana Mat-Nohjhil, a portion of which was re-surveyed subsequent to the drainage of the "jhil," a large sheet of water under which the lands of twenty-three villages were partially submerged at the time of first survey. The re-survey has caused delay, but the records are now nearly complete, and are promised at an early date.

Reasons for arrears.

223. It may be well to review the causes of delay in submitting records. In 1871-72, when cadastral surveys were first started, it was thought sufficient to furnish the Settlement Officer with a tracing of each village on cloth, giving the areas of fields in the vernacular khasra forms. The sheets were not then of uniform size, nor were they mapped up to margin; they were irregular blocks mapped as surveyed at more or less the whim of the field surveyor. They were eminently unsuited to photozincographic reproduction. In 1873-74 this system was abandoned, and a standard-sized sheet adopted. It was required that each village should be mapped in sections completed to margin, so that each section could be accurately aligned with its adjacent one. A more scientific system of recording the measurements of fields in field books was also instituted. It was thus found necessary to direct Colonel Anderson to re-draw the greater portion of the first two years' maps, amounting in all to 1,800 sheets. He has thus been heavily weighted with old work, which has since continued to keep his current work in arrears.

In order to work off these arrears, an additional sum of Rs. 14,340 was placed by the Surveyor-General at Colonel Anderson's disposal; this sum has enabled considerable progress to be made.

"Badar" system abolished.

224. During the past year the most serious hindrance to the final completion of cadastral records has been happily removed. Hitherto, the maps and records

prepared by the Survey were not accepted by the Settlement Department until they had been examined *in situ*. This examination occasionally brought to light that some few fields had been clubbed together; or, where the examination by the Settlement Department was not made soon after survey, that the limits of cultivation, &c., had changed. This led to the submission of *Badar* or error statements. Thus, the survey records were necessarily kept open and incomplete till all the *Badar* lists had been received and recorded.

It will now remain with the settlement officer to complete, and record on the maps what he finds has been omitted by the Surveyors.

For the four * permanently-settled districts which remain to be surveyed cadastrally, the Board of Revenue, North-Western Provinces, on my suggestion, have also directed the discontinuance of this *Badar* system. Consequently, there should now be no difficulty in publishing the cadastral sheets within a few months after they have been lodged in this Office, provided that the Photozincographic Branch of the Surveyor-General's Office is able to cope with the number of maps annually prepared.

* Jaunpur. Ghazipur. Benares: Mirzapur.

The "Badar" lists of Parganas Sihonda and Darsenda of District Banda, surveyed in season 1876-77, were received from the Settlement Officer towards the close of the past field season; they met with immediate attention, and have been disposed of, so that the records of these parganas are now finally completed.

Boundaries and demarcations.

225. The southern boundary of the Banda District marches for about 400 miles with the small independent States of Gaurihar, Charkhari, Panna, Pathar Kachhar, Chhatarpur, and Rewah. This boundary was laid down in 1870-71, and subsequently approved by the Government of India. It was, therefore, absolutely necessary that it should be scrupulously adhered to. For the identification of the line, the Deputy Superintendent reports that the existing maps were obtained from the Collector's Office. The demarcations in the plains were well defined and easily found, being marked by masonry pillars; but—

"in the neighborhood of the hilly tracts the verification of the old ratified boundary is a more difficult task, and the determination of the exact positions of the original pillars may, perhaps, be found impracticable. The maps above referred to are on too small a scale (2 miles = 1 inch) to be of any use for the restoration of a boundary, of which no trace can be found on the ground. They are unaccompanied by any record of either linear or angular measurements. The brush has been used for the delineation of the hills by washes of Indian ink, and the drawing has been too roughly executed to afford assistance in an attempt to renew the boundary marks; but this only offers a practical illustration of what has so often been observed, that in surveying, as in every other branch of the executive, the man of trained professional skill is the only one who can be trusted to do efficiently the work of that particular department to which he belongs. It is the neglect of this rule which has led to maps being lodged in Government offices, which, when made over to the professional surveyor for restoration or identification of an old boundary, are found by him to be perfectly useless."

In the neighborhood of Rasin, bordering on the Chaubipur Illaqua, some serious discrepancies have been found to exist. The above will be further enquired into and reported on during the coming season.

Permanent marks.

226. Along the exterior limits of villages the theodolite stations were permanently marked previous to survey by stone pillars embedded about 1 foot 9 inches under ground, leaving about 9 inches above the surface. During the past year 3,743 of these stones have been sunk, averaging 12¾ per village or 6 per square mile. These stones are fixed by the line-cutters when clearing the theodolite rays. The trijunction points of villages, 713 in number, have been also permanently marked by the Settlement Department with stones 12 inches square, about 3 feet long, embedded in masonry; both marks are shewn on the maps, and are made over to the charge of the Collector. In all future additions to the present survey these points cannot fail to prove most valuable.

Operations in prospect.

227. During the coming season, the unsurveyed area of Banda, about 550 square miles, will be taken in hand and probably completed, as also about 100 square miles of independent territory topographically. The southern portion of

Badausa Pargana is more or less hilly, and contains patches of forest reserves, which will be surveyed on the 4-inch scale, provided the demarcations are laid down, of which due notice has been given.

No. 2759A, dated 13th September 1878.

Under the orders of Government, marginally quoted, the cadastral survey of Mirzapore, one of the permanently-settled districts in the North-Western Provinces, will be next taken up for survey by this party. The Deputy Superintendent expects to have an area of about 250 square miles of traverse work got ready in advance for future operations.

Publication of maps.

228. For the reasons given in paragraph 214, under head 4th Division, it was determined that some portion of the maps awaiting publication in Colonel Anderson's office should also be published by lithography at the Government Press at Allahabad. An extra establishment was organized for this purpose, and 843 sheets traced on transfer paper and forwarded to Press, *viz.*, of—

	Sheets.
Pargana Banda	404
„ Pailani	380
„ Augasi	59

The cost of this work, including the examination of the proofs and the re-tracing of 92 sheets that failed in transfer, amounted to Rs. 3,332-12-9.

Personnel.

229. Mr. Jackson, Assistant Superintendent, has been throughout the year attached to this establishment. His services were referred to in paragraph 66 of last year's report; he has held charge of a camp since October 1877, both in the field and recess. In his own labours he is painstaking and unsparing, and said to be more than an average draftsman, and to possess a good knowledge of his duties. Of his individual work no complaint is made; but as an administrative officer it is reported that—

"He has not sufficient command of temper, and is wanting in tact in dealing with his subordinates both European and Native. These, for an officer in his position, are grave faults, but I do not think he has failed to benefit by the lessons and admonitions he has from time to time received during the past twelve months."

All the other Assistants have worked well and given satisfaction.

Levelling.

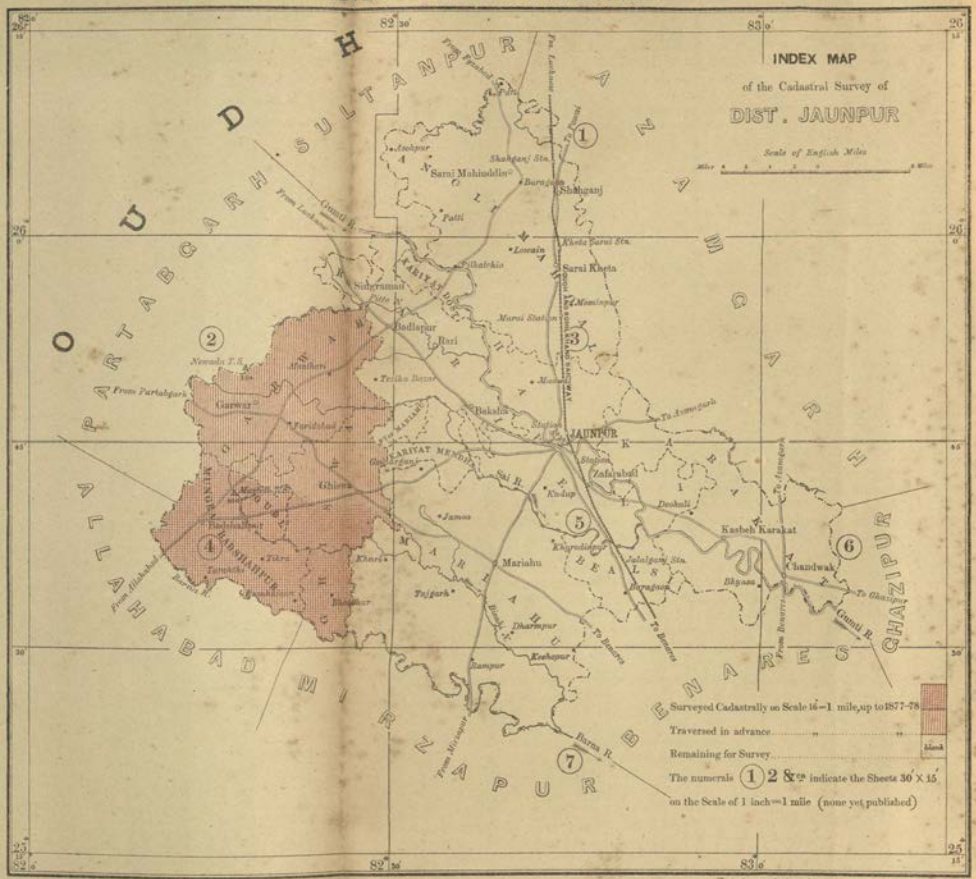
230. The levelling operations have been executed by Mr. E. P. Hill, who commenced field work on the 1st October 1877, and continued on that duty up to the 14th April 1878. During this time the values of 258 points were fixed in Parganas Badausa, Banda and Sihonda. The total expenditure, including the embedding of mark stones, was Rs. 3,266-14-2. The distance levelled over was 391·6 miles, giving an average cost of Rs. 8-5-5 per running mile. In the previous season the rate was Rs. 7-10-8. The average closing error is 0·035 of a foot per 10 miles: an average of one bench mark to every 1·6 square miles of country, has been obtained. The field books have all been brought up during the recess, and the necessary corrections applied to the different series, and the lines recorded on the 4-inch sheets.

In prospect for the coming season there remain about 400 miles to be done. Mr. P. C. H. Smart will relieve Mr. Hill, and conduct these operations, which, it is hoped, will be completed before the season closes.

Inspection.

231. During my inspection of this party in October, my attention was more specially directed to the actual progress that had been made in bringing up the heavy arrears of work which was reported on by me in October 1877. Much has been done, but much still remains to be done in this direction. This object should be steadily kept in view before the establishment is allowed to enter upon the cadastral survey of the Mirzapur District. It is obviously desirable that we should be off entirely with the old work in Banda before we are on with the new work in District Mirzapur.

REVENUE BRANCH SURVEY OF INDIA



Photozincographed at the Surveyor Generals Office, Calcutta

Published under the direction of Colonel J.T. Walker C.B. R.E. F.R.S. Surveyor General of India.

Surveyor General's Office, Calcutta February

1879

VI.—6TH DIVISION, REVENUE BRANCH.

DISTRICT JAUNPUR.

Commencement of operations.

232. The transfer of this establishment from Districts Gya and Patna to the North-Western Provinces was referred to in paragraph 89 of last year's Report. Before moving into the new district it was necessary that the records of Patna and Gya should be completed; the establishment remained therefore for this purpose at Hazaribagh till the 17th December, when it moved to Jaunpur to commence work in Tahsil Machlishahr, detaching a small party to Patna with Mr. Talbot, under the charge of Major Sconce of the 8th Division, with the object of completing the Eastern Soane tracts.

233. The strength of the establishment with Mr. Johnson is given in the margin. The portion of the district commenced on was the south-west, bordering on Oudh and Allahabad. Field operations may be said to have fairly commenced in the first week of January. The scale of survey was that of 16 inches to a mile, the usual cadastral scale for these provinces, the field being the unit of measure.

ESTABLISHMENT.

Mr. E. T. S. Johnson, Deputy Superintendent, 3rd grade.

Assistants.

Mr. P. A. G. Cowley, Surveyor, 3rd grade.
" E. J. Martin, Assistant Surveyor, 3rd grade.
" A. W. Smart, " " "
" E. H. S. Gasper " " 4th grade.
20 Sub-Surveyors, &c.

Outturn.

234. The following abstract statement shows the area completed in detail:—

PARGANA.	Villages.	Fields.	Acres.	Square miles.	Average size of fields.
Mungra	103	172,664	55551·04	86·80	0·32
Ghiswa (portion of)	112	126,876	40953·60	63·99	0·32
TOTAL	215	299,540	96504·64	150·79	0·32

The size of the fields given above includes large patches of barren waste; if these patches be excluded, the average size of the field is 0·24 of an acre. Considering the late date at which field operations were commenced, and this being the first season in a new district, the out-turn is as large as could be expected, and reflects credit on Mr. Johnson.

In addition to the above area, 193·18 square miles have been traversed in advance for the coming season.

Field work was closed on the 15th April, when the establishment returned to Hazaribagh for recess duties.

Check and verification of work.

235. The Great Trigonometrical Survey station of Manrardih, the only point of that survey falling within the district, has been made the origin.

The meridians have been verified by the observation of 20 azimuths, observed to different stars.

The traverse survey measurements aggregated 1,533 miles, and include the observation of 9,328 angles.

The work of the field surveyors has been tested by 392 miles of check survey run by the European Assistants and Native Inspectors. Every village has been checked by two, if not three, lines. Every check line is compared with the field survey by European officers only.

Chaining per acre.

236. The average chaining in twenty different villages, excluding the traverse survey, is found to be as follows:—

Total area in acres	6309·0
Total number of fields	19504
Average size of fields	0·32
Total of measurements in chains	79255·0
Average number of chains measured per acre	12·56

237. When the field work commenced, there being no traverse work ready in advance, the amins were first started without any plotted points to work upon. Precautions were, however, taken to mark the theodolite stations on the ground before any cadastral measurements were commenced. The field surveyors plotted their sketch books from the measurements, as they proceeded, on the scale of 32 inches to a mile. As soon as a village or section was done, the field sketch books were sent to the camp office, and there plotted by a staff of plotters kept for the purpose. At first the progress was slower than the system of permitting the amin to plot the maps *in situ*, but correct field books were thereby guaranteed.

Field records.

238. The principal records prepared are given in table C: those for this office are promised during December next; they have been necessarily detained for some alterations in boundaries.

Recess records.

239. The demarcations had, fortunately, been attended to in anticipation of a survey party being sent. The boundaries as surveyed and those of the settlement maps are found to agree well; but in the course of the preparation of the maps, it was discovered that the district boundary adjoining Allahabad had not been laid down with reference to the original maps of that district, and hence the boundaries and area will have to be revised. Mr. Ward, the Collector, has aided the survey. The Tahsildar has also given great assistance in the matter of supplies.

Demarcation.

240. The triple junction points of villages were found marked by stones. In all cases these have been used as traverse stations. In addition, the nearest stations on either side have been marked by burnt clay cylinders 20 inches long. Of these, 3,525 have been embedded. These latter will last for some years if left undisturbed.

Permanent marks.

241. There is ample work in this district to employ this party for some years, the area left for survey being about 1,400 square miles. Operations will be first undertaken in Parganas Ghiswa, Garwara, and Mariahu.

Work in prospect.

242. Mr. Talbot's services are reported on under head 8th Division. The whole of Mr. Johnson's Assistants are favorably noticed, but especially Mr. Cowley and Mr. A. W. Smart.

Personnel.

243. The party was inspected in August at its recess quarters, Hazaribagh, where a fine building belonging to the Government, and formerly occupied as a mess-house, has been placed at the disposal of this Department and used as an office. I found both the maps and calculations well in hand, and the Deputy Superintendent, Mr. Johnson, himself exercising a most vigilant, close supervision over the work, which was being systematically proceeded with, and entirely to my satisfaction. Whatever this officer undertakes he is sure to do well.

Inspection.

VII.—CADASTRAL REVISION SURVEY.

Districts Agra and Hamirpur.

244. The necessity for this establishment was explained in paragraph 73 of last year's report; the duties are the revision and completion of the cadastral records of Districts Agra and Hamirpur. The field re-measurements were completed by the end of December 1877, when the office was moved to Calcutta.

Resumption of work.

Establishment.

Mr. James Campbell, Officiating Deputy Superintendent, 3rd grade.

Assistants.

Mr. P. E. Heberlet, Assistant Surveyor, 3rd grade, transferred from 7th Division Survey from 1st April 1878.

„ O. D. Smar', Office Assistant, appointed 15th February 1878.

28 Amins, &c.

Mr. Campbell, on rejoining from furlough on 7th January, was appointed to relieve Captain Andrew of the charge of the party, as the latter was required for District Cuttack. The following sheets at that date required to be completed and rendered suitable for photozincography, *viz.*,—

	Sheets.
Of District Hamirpur	1,982
„ „ Agra	1,513
Total .	3,495

The space in the head-quarters office did not admit of Mr. Campbell's office continuing in Calcutta. He was consequently ordered up to Hazaribagh in February, where office accommodation was readily available, free of rent, to the Government.

Work completed.

245. Between the end of December 1877, and February 1878, a large number of copies of the Azamgarh maps had been corrected and lodged in the Head-quarters' office prior to departure to Hazaribagh; since then, up to the 1st October, the sheets of Hamirpur (34 excepted) have been completed and despatched, ready for press. The 34 sheets contained errors requiring reference to the Settlement Office, and are necessarily retained; sixty-one volumes of village field books have been indexed, and the triangles numbered therein, as well as on 658 sheets where they had been omitted.

Personnel.

246. Mr. Campbll reports that the whole of the remaining work will probably be finished by June 1879. His duties have been arduous, requiring much patience and careful examination of original records, with the view of clearing up obscure and doubtful rendering on the cadastral sheets. During my inspection of his office at Hazaribagh in August last, I was satisfied that these duties had been entrusted to a zealous, painstaking officer, and were being well carried out by him.

Mr. Campbell writes in terms of praise of Mr. Heberlet, who rendered him great assistance. He also found Mr. Smart very useful and willing.

BENGAL.

VIII.—7TH DIVISION, REVENUE BRANCH.

KHORDA GOVERNMENT ESTATE, DISTRICT POOREE.

247. THIS division has remained throughout the year under the charge of Mr. R. B. Smart, Deputy Superintendent, with an establishment of the strength recorded in the margin.

Establishment

Mr. R. B. Smart, Deputy Superintendent, 2nd grade.

Assistants.

Mr. E. C. Barrett, Assistant Superintendent, 1st grade, transferred to 9th Division Survey from 1st May 1878.
„ A. D. Smart, Surveyor, 3rd grade, transferred from Head-quarters' Office, Calcutta, from 23rd October 1877.
„ C. David, Surveyor, 3rd grade, transferred from 9th Division from 1st June 1878.
„ W. R. Vyall, Surveyor, 4th grade.
„ H. Dowman ditto.
„ T. H. Dunne, Assistant Surveyor, 1st grade.
„ G. Campbell ditto 3rd grade.
„ P. E. Heberlet ditto 3rd grade, transferred to North-Western Provinces Cadastral Revision Survey, from 1st April 1878.
26 Sub-Surveyors, &c.

Mr. E.C. Barrett, the Assistant Superintendent, was transferred in May last to the 9th Division on the departure of Captain Andrew to Europe on medical certificate. The field operations commenced by the middle of December, but were not in full force till the end of that month.

The survey is, owing to the small size of the fields, still necessarily continued on the scale of 32 inches to a mile. Measurements were carried on in Zillas Dandimal, Tapang, and Rameswar.

Season's outturn.

248. The following is an abstract statement of the area completed:

Names of Zillas.	Villages.	Fields.	Acres.	Square miles.	Average size of fields.
Dandimal and Haldia	111	266,803	91564·80	143·1	0·34
Tapang and Khorda	55	120.132	32842·66	51·3	0·27
Rameswar	81	125,196	35637·34	55·6	0·29
TOTAL . .	247	512,131	160044·80	250·0	0·31

All details of cultivation, culturable, barren waste, hills, forest, &c., have been separately delineated. In addition to the above, a further area of 160 square miles, containing 388 villages, has been traversed and got ready in advance; the traverse survey of the season embraced the measurement of 2,611 miles of chaining.

In comparing the 32-inch work done in Khorda with that of the 16-inch work in Hamirpur, (North-Western Provinces,) Mr. Smart finds that, in addition to the mapping being quadrupled, the measurements are also increased fourfold, and that the same amins who could in Hamirpur give in a daily average outturn of 30 to 50 acres can with difficulty in Khorda accomplish 10 acres. In Hamirpur the fields were large, and averaged 1·7 acres.

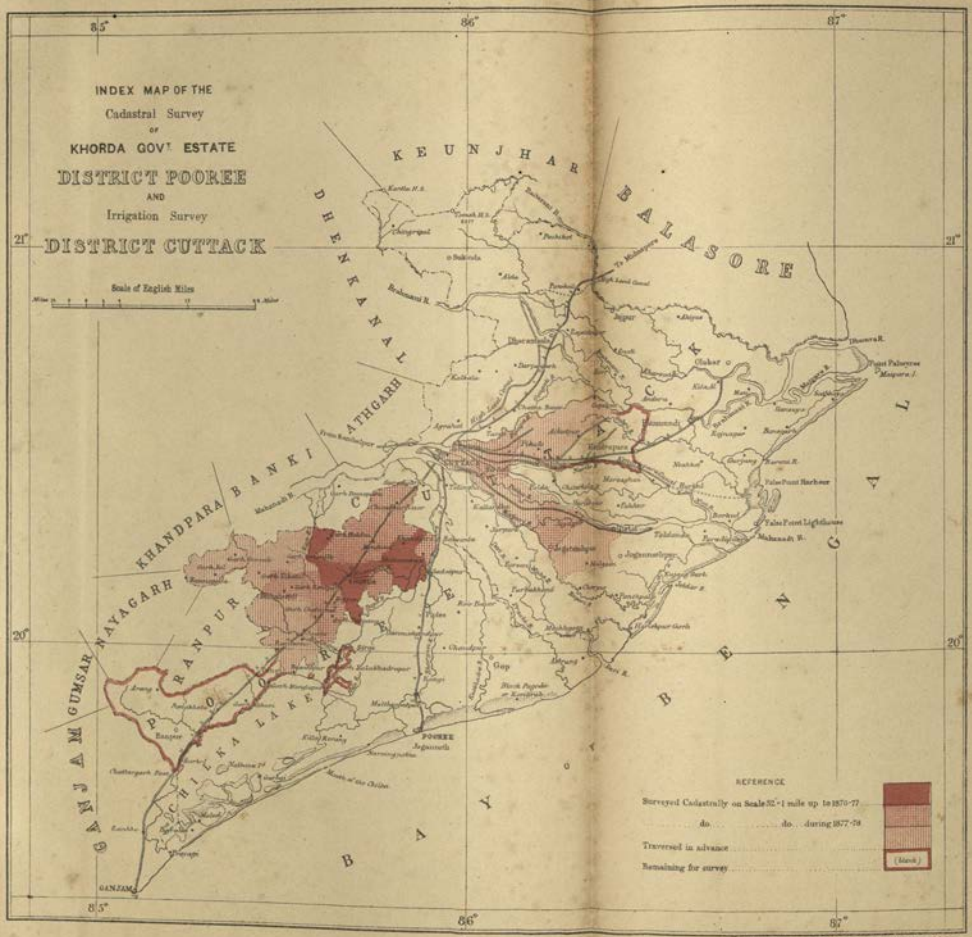
Average chains measured per acre.

249. During the past season, in order to complete one acre of ground, the measurements averaged 17·42 chains, exclusive of the traverse work,; each line measured averaged 86 links. The season's outturn therefore necessitated measurements equivalent in a straight line to 34,850 miles.

Check survey and verification of work.

250. To test the amins' field work, 318 miles of check line were run by the Native Inspectors and 228 by the European Assistants. In addition, the amins were daily visited and supervised at every stage of the work.

REVENUE BRANCH, SURVEY OF INDIA



Photozincographed at the Surveyor Generals Office, Calcutta.

Published under the direction of Colonel J.T. Walker, C.B., R.E., F.R.S., Surveyor General of India.

Surveyor General's Office, Calcutta February

1879

The check surveys are made by field-book entry, and after being plotted, are traced on vellum cloth, and applied to the plan; thus any discrepancies that exist become at once apparent.

The field boundaries are plotted *in situ* by the Amins, who are required to leave them in pencil. On the map and field sketch book being forwarded to the camp office, ten per cent. of the plotting is tested, and if found correct, the field boundaries are then inked in.

The angular work was tested and corrected by the observation of 21 azimuths, all meridians being referred to the origin of survey.

Three additional stations of the Great Trigonometrical Survey Coast Series fell within the season's operations, and were connected with the main circuit traverses.

The following table shews the average error per mile in feet:

Great Trigonometrical Survey Stations.		Direct Distance.		Difference in feet.	Error per mile.
From	To	By Great Trigonometrical Survey in feet.	By Revenue Survey in feet.		
Mahaparbuth . . .	Kansaree . . .	33533·28	33529·12	— 4·16	—0·65
Doodua	Daolia . . .	103150·08	103144·20	— 5·88	—0·30
„	Kansaree . . .	57235·20	57232·23	— 2·97	—0·27
Burnai	Daolia . . .	47456·64	47464·86	+ 8·22	+0·91
„	Kansaree . . .	49067·04	49055·03	—12·01	—1·29
Sardai	Burnai . . .	64241·76	64252·98	+11·22	+0·92
„	Banki	68053·92	68061·21	+ 7·29	+0·56
„	Doodua . . .	64331·52	64340·10	+ 8·58	+0·70

Revenue Survey average error where + ... 0·76
Ditto ditto — . . . . . 0·54

These close results shew that the traverse survey has been very carefully conducted.

Field operations closed.

251. The field operations were brought to a close on the 15th June, when the establishment returned to Cuttack and commenced recess duties. The field season continued for six months.

Recess duties.

252. The mapping and computation of the area extending to the 512,131 fields has rendered the recess duties unusually heavy. The area of each field is deduced by two independent computors; the results are then compared as far as three places of decimals. After comparison all discrepancies are re-worked (usually about ½rd of the whole). The final areas are then entered in the vernacular (Ooriya) forms for the Settlement Department, and in English for the Headquarters' Office; both are then separately added up, compared, and finally passed. The mapping and principal records prepared are given in table C.

Prior to the 1st October 1877 the khasras and first traces of 247 villages had been furnished to the Settlement Officer. Of this number, 185 have been examined and finally passed. It was found that as many as 715 fields were added after survey, and that where Amins were subsequently sent to record these fields, 88 of the number were still found unmarked on the ground.

The 4-inch atlas sheets are under preparation; 12 are completed, and 8 are in progress. The reduction by pentagraph from the 32-inch scale is found to be very laborious, entailing the setting of the pentagraph on an average 130 times for each sheet.

Demarcations.

253. Reference has been made above to the large number of fields that remained unmarked at the time of first survey. Mr. Smart has had reason to complain of defective demarcations for the past two years. These were prominently brought to notice in para. 100 of last year's report, and led to a long

correspondence with the Board of Revenue. It is therefore greatly to be regretted that this subject has again to be noticed, and a record made that increased expenditure has been caused thereby.

The following tabular statement shews the result of the revision survey:

Names of Zillas.	Season of survey.	Number of villages.	Number of fields originally found marked.	Number of fields added by Settlement Officer.	New fields by Settlement Officer found marked.	New fields by Settlement Officer not marked.
Dandimal	1876-77 . .	94	126,692	555	512	43
Khorda , . . .	1876-77 . .	91	174,128	160	115	45
		185	300,820	715*	627†	88‡

* Not on the ground at the time of 1st survey.
† Found marked at time of 2nd survey.
‡ Still unmarked at time of 2nd survey.

Permanent marks.

254. All the triple junction points of villages are marked by stone pillars 4 feet in length by 1 foot square. The two theodolite stations on either side of the trijunctions have been further marked by stones 2 feet long by 6 inches square. In addition, the small stones used in demarcating the boundaries have been, where possible, used as theodolite stations; and as all permanently marked points have been shewn on the maps, ample provision has been made in order that any future additions to the present survey may be done with facility.

Operations in prospect.

255. The area remaining for survey in Khorda will keep the establishment engaged for two more seasons. During the coming season, cadastral measurements will be carried on in Zillas Kuspala, Panchgarh, and Mankagorah, all of which will probably be completed, together with as much of Rameswar, Kohuri, and Dandimal as may be found possible. Traverse survey will also be extended to Zilla Bhanpur.

Personnel.

256. Mr. Barrett's transfer to the 9th Division has been seriously felt by Mr. Smart, as no Assistant Superintendent has been available in his place. The Assistant Surveyors are all represented to have worked well, and to be deserving of credit. Mr. Dowman's services are especially mentioned, as also those of Mr. George Campbell.

The native establishment has also worked well and given satisfaction.

Inspection.

257. During my visit to Cuttack in May 1878, the conduct of the professional survey was discussed at a meeting or conference held in the Commissioner's house on the 14th May, where the officers named in the margin were present. The result of the conference was duly communicated by me to Mr. Dampier, at his own request, in my memorandum dated 31st May 1878.

Mr. A. Smith, Commissioner.
„ J. S. Armstrong, Collector.
„ H. C. Taylor, Settlement Officer.
„ C. Brownfield, employed on boundary demarcation.
„ R. B. Smart, Deputy Superintendent, Survey.
General Vanrenen, Deputy Surveyor General.

There had been considerable friction between the Deputy Collector, Mr. Taylor, and the Deputy Superintendent, Mr. Smart, owing to undue interference on the part of the former officer with the latter's duties. This elicited from me the following remarks, which will be found in the memorandum referred to: "It seems to me the energies of the Settlement Officer should rather be directed to authoritatively demarcating village homesteads prior to survey, and judiciously employing his Amins on that work, than in attempting resurveys of fields." Mr. Smart is an officer of vast experience, and needs no instruction from Mr. Taylor as to how his duties of a Surveyor should be conducted. He has surveyed in the North-Western Provinces the largest cadastral area of any Surveyor in the Department, and needs no urging, being a very zealous and energetic officer. Under the exceptional difficulties which he has encountered in Khorda, he has got through a large amount of work, and done it well, both in the field and in office.

REVENUE BRANCH SURVEY OF INDIA

INDEX MAP OF THE SOANE IRRIGATION (CADASTRAL) SURVEY, DISTRICTS SHAHABAD, GYA & PATNA.

Published under the direction of Colonel J. T. Walker C.B. R.E. F.R.S. Surveyor General of India.

Surveyor General's Office, Calcutta, January 1879.

Photolithographed at the Surveyor General's Office, Calcutta

IX.—8TH DIVISION, REVENUE BRANCH.

SOANE IRRIGATION TRACTS.

Operations resumed.

258. This establishment has continued throughout the year under the superintendence of Major J. Sconce. At the time of the submission of last year's report, it was in contemplation that the entire irrigable area of Shahabad District would be surveyed. During October 1877 the programme was suddenly changed, at the request of the Irrigation Department and of the Bengal Government; field operations were limited to the area irrigated from the Arrah branch canal, the area irrigated from the Buxar branch canal being struck out.

The area for cadastral survey in District Shahabad was thus reduced to 145 square miles, exclusive of 28 square miles of non-irrigable land through which the main canal passes for 7½ miles. Of the latter, only a 4-inch survey was required for topographical purposes.

The reduced area left for survey in District Patna on the eastern bank of the Soane was 195 square miles. Thus, the total area for survey both in Shahabad and Patna was 340 square miles, which could not occupy two full survey parties. The 6th Division was accordingly transferred to Jaunpur District, leaving a detachment under Mr. Talbot to complete the Patna District, the whole establishment being placed under Major Sconce's orders. The above was referred to in paras. 89 and 90 of last year's report.

WESTERN SOANE IRRIGATION SURVEY.

Major J. Sconce, Deputy Superintendent, 2nd grade.

Assistants.

Captain S. H. Cowan, Assistant Superintendent, 1st grade, transferred to Head-quarters' Office, Calcutta, from 1st March 1878.

Lieutenant G. W. Martin, Officiating Assistant Superintendent, 2nd grade, transferred from Head-quarters' Office, Calcutta, from 1st March 1878; relieved of his duties on the afternoon of 22nd July 1878, his services having been ordered to be placed at the disposal of Financial Department (for an appointment in the Calcutta Mint).

Mr. F. Grant, Surveyor, 2nd grade.
„ G. Rae, ditto, 3rd „
„ T. Shaw, Assistant Surveyor, 2nd grade.
„ G. H. O'Donel, Assistant Surveyor, 4th grade, permitted to resign from 5th June 1878.
„ T. Campbell, Assistant Surveyor, 4th grade.
28 Sub-Surveyors, &c.

EASTERN SOANE.

Assistants.

Mr. H. B. Talbot, Officiating Assistant Superintendent, 1st grade.
„ J. H. O'Donel, Assistant Surveyor, 1st grade.
„ J. S. Swiney, Assistant Surveyor, 2nd grade.
20 Sub-Surveyors, &c., (from 16th December 1877.)

Outturn.

259. The field parties of the 8th Division, Shahabad District, assembled at Arrah on the 1st November, and those of Patna at Dinapore on the same date. The out-turn is given in the following statement:

DISTRICTS.	Villages.	Fields.	Acres.	Square miles of fields.	Average size.
32-inch scale.					
Shahabad (Western Soane)	298	309,407	92869·12	145·11	0·30
Patna (Eastern Soane)	465	377,541	124785·13	194·97	0·33
Total ...	763	686,948	217654·25	340·08	0·32
4-inch scale.					
Shahabad	Non-irrigable area				28·33
	Overlap beyond railway				26·40
	Total 4-inch ...				54·73
	Total area surveyed ...				394·81

Average of chain measurements.

260. In District Shahabad, in ten villages selected in different portions of the work and with fields of about the general average size, the following statement shews the result of the measurements made in surveying the fields:

Total acreage	2833·60
Number of fields	11008·0
Average size of fields	0·25
Total measurements in chains	33907·62
Average chaining per acre	11·96

or an average of 7654·4 chains in every square mile of country.

In Patna, in a similar number of villages, the following results were obtained:—

Total acreage	2608·8
Number of fields	9604·0
Average size of fields	0·27
Total measurements in chains	37621·0
Average chaining per acre	14·42

In both the above results the traverse survey and check survey measurements have been excluded.

Field records.

261. An Inspector was appointed to supervise the work of every ten Amins in the field. To the Inspector was also entrusted the check or purtal survey. This system, which is as follows, was found to work very satisfactorily. Immediately on receipt of the completed sheets of a village, the officer in charge of the camp marked out the lines for purtal on a rough sketch of the village boundary, which was then sent to the Inspector, who was on completion required to send his field book into camp, where the comparison was made personally by the camp officer. The comparison shewed that the survey was accurately and carefully done, very few revisions being found necessary.

Records.

262. Six hundred and fifty-three cadastral sheets, on the 32-inch scale, containing 298 villages, have been prepared, and are nearly completed; 4-inch atlas sheets of the whole are in an advanced state, as also the khasra volumes, alphabetical indices, &c.; all will be ready for submission by December next.

During December 1877 the Irrigation Department expressed a desire to be furnished with three extra copies of the khasra and area statement of every village that had been surveyed since the commencement of survey operations. As the number of villages surveyed was 1,740, this proved a very heavy piece of work. The demand was, however, met by giving the work out on contract. The area statements were paid for at the rate of 2 annas per page, and the khasras at 3 annas per 100 lines.

A large portion of the establishment was necessarily left at Hazaribagh throughout the year. They were busily employed in bringing up the records of the past seasons, in making copies of the khasras, and in preparation of transfer traces for lithography. The principal records prepared will be found in table C.

Demarcations.

263. The demarcations have been satisfactory. The whole course of the operations in District Shahabad have been greatly assisted by Babu Harsahai Singh, Deputy Collector, who was appointed to settle boundary disputes, and to aid the survey in obtaining a correct definition of village boundaries. His local influence was of great value, especially at the commencement of the survey operations, in overcoming the prejudices of the people against the survey. His enquiries into cases of disputes have been most thorough. His good services are recorded with much pleasure.

Operations in prospect.

264. The work allotted being almost completed, the establishment is gradually being reduced by transfers to other parties. Some have been sent to Darjeeling, others to Sylhet; the greater portion of the remainder will form the nucleus of a party required under the recent orders of the Government of India for a cadastral survey in Cachar.

Personnel.

265. Major Sconce writes: " I cannot speak too highly of Captain Cowan's services. He has great capacity for the management of a large office."

Lieutenant Gerald Martin, during the short time he was attached, worked with energy.

Mr. Grant has worked zealously, and with great patience. The remainder are favorably reported on, except Mr. Shaw, who has shewn a want of zeal.

The charge held by Mr. Talbot, the Assistant Superintendent detached from the 6th Division, has been more independent than the ordinary control of

a camp. He has given entire satisfaction, both in the field and in the way in which he has brought up his office work.

Major Sconce further states that his acknowledgments are due to Mr. E. T. Johnson, Deputy Superintendent of the 6th Division, for the very efficient establishment which he detached under Mr. Talbot.

Inspection.

266. In inspecting this establishment in August last at Hazaribagh, I was struck with the order in which every step of the work was being carried out, and with the enormous amount of mapping and calculations necessary to bring the cadastral surveys in Behar to a close. This has been most satisfactorily completed under the able management of Major Sconce, the Deputy Superintendent, assisted as he has been most ably, by Captain Cowan and by Messrs. Talbot and Grant. Many of the Native draftsmen and computers were working well, and doing hard, honest work. Major Sconce's own labors have been incessant. What he has turned out is so complete, as to be deserving of the highest commendation.

X.—9TH DIVISION, REVENUE BRANCH.

CUTTACK DISTRICT (IRRIGATION TRACTS).

267. A survey party of the strength given in the margin was at very short notice raised, at the request of the Government of Bengal, to meet the requirements of the Irrigation Department for a cadastral survey of the irrigable lands of Cuttack. The establishment was got together partly from the revision party that had been at work in the North-Western Provinces, and partly from the late 14th or Dearah party.

Establishment

Captain D. C. Andrew, Deputy Superintendent, 3rd grade, on furlough on medical certificate to Europe from 28th May 1878.
Mr. E. C. Barrett, Officiating Assistant Superintendent, 1st grade, in charge from 23rd May 1878.

Assistants.

Mr. C David, Surveyor, 3rd grade, transferred to 7th Division Survey from 1st June 1878.
„ H. R. Littlewood, Surveyor, 3rd grade.
„ J. R. Scott, Assistant Surveyor, 2nd grade.
„ G. L. R. Scott ditto, 2nd „
„ C. W. J. Ford ditto, 3rd „
„ B. M. Wilson ditto, 3rd „
„ H. R. Adels ditto, 4th „
35 Sub-Surveyors, &c.

Captain Andrew, Deputy Superintendent, was placed in charge, and assumed active duties at Cuttack on the 14th December. He remained in charge till the 23rd May, when, through the effect of a severe sun-stroke, he was ordered to England on medical certificate. On his departure he was succeeded by Mr. Barrett (from the 7th Division), who has since supervised the work. The scale of survey was fixed at 32 inches to the mile, the fields being too small to be mapped on any lesser scale.

The area for which a cadastral survey was required is 465 square miles, made up of disconnected and irregular blocks of land lying along the courses of the several irrigation channels that issue from the Mahanadi river in the vicinity of Cuttack, and flowing for the most part in a south and easterly direction.

Outturn.

268. The field parties were organised and ready to commence work by the beginning of January. The Settlement Department Amins had commenced demarcation work only one month previously, so that but little actual progress had been made; and Captain Andrew, on his arrival at Cuttack on 14th December, found that the demarcation done extended only to detached blocks of villages. He, however, determined to start his boundary Surveyors at once, with instructions to overtake and to keep pace with the Demarcation Amins. The Amins were almost at once overtaken, and then delay ensued. It was not till the 5th March that cadastral mea-

surements were really fairly commenced, as, although desultory work was attempted, the Survey Amins could not be furnished with plotted points before that date. The area completed by the close of the field season was 67·8 square miles, with an additional area of 216 square miles of traverse survey in advance. The following statement gives the area in detail:—

Names of Parganas.	Villages.	Fields.	Acres.	Square miles.	Average size of fields.
Padmapur	49	116,175	21438·5	33·5	0·184
Kodinda					
Korimal					
Bakrabad					
Balubisi	98	129,961	21973·5	34·3	0·169
Hariharpur					
Pænda					
Total ...	147	246,136	43412·0	67·8	0·176

In the execution of the traverse survey, angular observations were made at 9,264 stations. The chain measurements amounted to 1,316 miles.

Average chaining per acre.

269. In 20 average-sized villages, with fields of an average size, it is found that the cadastral measurements averaged as much as 20·89 chains per acre.

The small outturn is due to the following:—*1st*, and chiefly, that the demarcations were not ready in time; *2nd*, that this was the first year of a new party in a new district; *3rd*, that, the scale is large and the fields very minute; and *4th*, that the number of Amins available was limited, since it was not thought advisable to incur the expense of keeping more men idle while the traverse work and demarcations were being got ready.

Field measurements were continued up to the 20th June, when the establishment proceeded to Cuttack and commenced its recess duties.

Check and verification of work.

270. The Cuttack Fort station of the Great Trigonometrical Survey Coast Series was fixed upon as the origin of survey. The initial azimuth used being that of the line to Kaplas H. S., this latter station, also falling within the season's operations, was connected on. The following table shews the result of comparison of the direct distance obtained, with the error per mile in feet:—

Names of Stations.	Direct distances.		Difference in feet.	Error per mile in feet.
	By G. T. Survey, in feet.	By Cadastral Survey, in feet.		
Cuttack Fort to Kaplas H. S.	77138·33	77111·76	26·57	— 1·82

Check azimuths for verification of the angular work were observed at 38 traverse stations along the main traverses. The angular corrections averaged one minute in every 27 angles. In linear measurements the average corrections applied were in northing and southing ·5 of a link, and in easting and westing ·63 of a link per 100 chains.

To test the cadastral measurements, 103 miles of check survey were executed by the European agency, and 108 miles by Native Inspectors. An average of 3 linear miles of check has thus been run over each square mile of ground.

Field records.

271. The field sketch books in which the Amins entered their measurements were roughly plotted on the scale of 64 inches, or double the scale of the maps, The maps were plotted by the Amins, who made the measurements, from their own field sketch books. Afterwards 25 per cent. of the plotting was tested in

the Office. The field books are kept in Persian character, and are clean and neat. Out of 361 sheets, 3 were found to be inaccurately plotted and had to be re-done.

Recess duties.

272. The Irrigation Branch of the Public Works Department, which is paying for the work, preferred that all records should be submitted in English. In order to give effect to this wish, as very few of our field Surveyors possessed the requisite knowledge of English, those only who did were retained for recess, the rest being allowed to go on leave, and in their place Ooriyas and Madrassees were entertained. These last, though they understood English, had first to be instructed in survey duties before their knowledge of English could be turned to account; and this has entailed additional time and labor in finally closing the survey records, although the outturn was small.

Many local units of land measurement exist in the district, termed "*padikas*," ranging from a *padika* of 7 feet 4 inches to one of 15 feet 5 inches. After some correspondence it was settled that the *choubis dasta padika* should be adopted. This value is a very convenient one, as the "*mán*" and acre are identical. The English measurements are thus readily converted into *máns*, *ghoonts*, and *biswas*, in which the khasras or areas are recorded. This is no small gain, where so many figures have to be dealt with.

The cadastral sheets are all prepared suitable for photozincography.

The 4-inch atlas sheets have not been commenced, as, owing to the limited area surveyed, no single sheet could have been rendered complete.

Demarcations.

273. It has been already stated that the demarcations were not ready in time; and that the area that had been demarcated was of a detached nature, so that the main traverse survey could not be effectively prosecuted, and thus all other survey operations were hindered. It was further found that when the demarcations were ready, boundary disputes had not been adjusted, so that out of the 117 villages surveyed, the thakbust maps of 78, or over 50 per cent., disagreed with the marks on the ground: these had consequently to be returned for rectification or renewal. This matter, when brought to the knowledge of the Settlement Officer, was speedily rectified, and the Surveyor reports "that it is a matter for congratulation that the demarcations have been entrusted to an officer of Mr Beadon's experience, who thoroughly understands the wants of our department, and does his best to meet them; and I have every reason to believe that next season the demarcations will be all that can be desired." The orders of the Imperial Government for the survey in Cuttack were received on the 2nd October 1877. The Secretary, Board of Revenue, Lower Provinces, was addressed by letter on the 3rd idem as follows:—

"I have the honor to request that the Board will issue such orders for the early demarcation of village boundaries as will enable the Survey to break ground early in December next, as no work can possibly be attempted by the Survey until the executive officer in charge has received distinct information from the civil authorities that a properly demarcated tract of country has been prepared for the survey of at least 100 square miles as a commencement."

Thus, the earliest possible intimation was given as to the requirements of this department.

Permanent works.

274. Stones, measuring 3 feet by 15" by 15", have been fixed at the trijunctions of all villages; 4,242 theodolite stations have, in addition to the trijunction points, also been permanently secured by stones measuring 2 feet × 6" × 6". Thus ample points are secured for any additions to the present survey that may be desired at any future date.

Operations in prospect.

275. It is anticipated that an area of 220 square miles will be completed cadastrally in the coming season. The area apportioned for survey being 465 square miles, there will thus remain a probable area of 177 square miles for survey in 1879-80. The whole of the remaining traverse work will be completed during the ensuing season.

Personnel.

276. Messrs. H. R. Littlewood and J. R. Scott have been in charge of camps; their services are brought favorably to notice. The other European Assistants have worked well, and are commended.

The native establishment, taken as a whole, is not favorably reported on, but few have rendered approved service. Most of the Sub-Surveyors had had no previous cadastral training, and were only accustomed to the procedure followed in mouzawar work, and were found in a great measure too old to be instructed.

Opinion on outturn.

277. Taken in the abstract, the outturn is small; but, under the explanations given, and the unavoidable delays that occurred beyond the control of the Surveyor, the area accomplished must be considered as satisfactory, and as all that was possible. The unavoidable change in the executive charge, so close to the end of the field season, may perhaps have affected the outturn somewhat, as a relieving officer necessarily takes some little time before he becomes acquainted with the working of the several members.

Inspection.

278. When I visited Cuttack in May, the field survey parties were still at work, and but little of it had been brought in. I found the Executive Officer, Captain Andrew, very ill, and suffering from the effects of sun-stroke. He had been very eager and anxious about the survey; and this, I have little doubt, predisposed him for the attack. He is very painstaking and energetic in the performance of his duties. On being ordered to Europe on medical certificate, he was relieved in May last by Mr. Barrett, Assistant Superintendent of Survey, who has carried out the duties entrusted to him to my entire satisfaction.

XI.—BARKAGARH AND CHOTA NAGPORE ESTATES SURVEY.

District Lohardugga.

Operations resumed.

279. This half-strength survey party has continued under the charge of Captain Sandeman, with the establishment as per margin. At the time of taking the field, a change of procedure being desired by the Bengal Government, as referred to in paragraph 160 of last year's report, the survey operations were as far as possible confined to the "Barkagarh Estate." A reference to the index map will shew that the estate is a very scattered one, and has thus added to the difficulties of survey. The orders for survey are further given in the extract from Captain Sandeman's report, which will be found in the Appendix.

Establishment.

Captain J. E. Sandeman, Officiating Deputy Superintendent, 3rd grade.

Assistants.

Mr. D. A. King, Assistant Surveyor, 1st grade.
„ W. D. Corbett, Assistant Surveyor, 3rd grade, transferred to 4th Division Survey from 1st November 1877.
„ G. E. Parker, Assistant Surveyor, 3rd grade, transferred from 12th Division Survey from 1st November 1877.
8 Sub-Surveyors, &c.

Outturn.

280. Field operations were commenced at the end of November. The following is a statement of the outturn completed, inclusive of the 23,040 acres partially surveyed during the previous season:

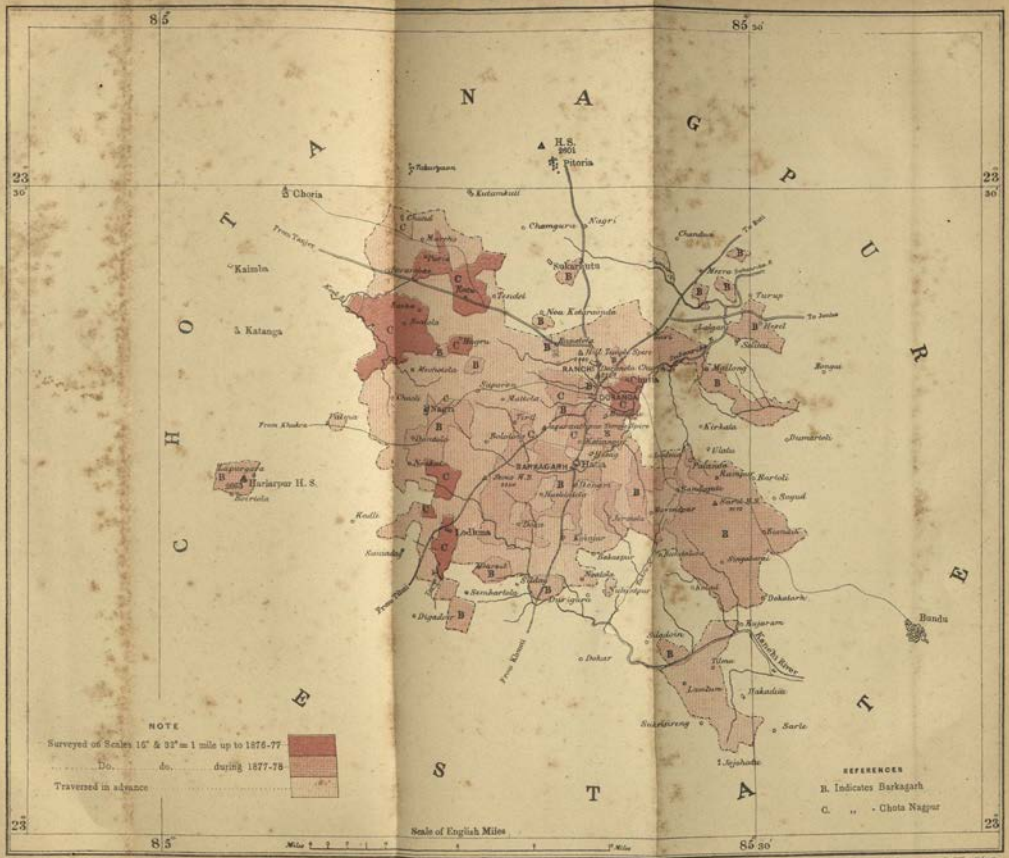
Estate.	Number of villages.	Number of fields.	Area.		Average size of fields.
			Acres.	Square miles.	
Barkagarh	81	265,000	68888·85	107·64	...
Chota Nagpore	34		27840·01	43·50	...
Total ...	115	265,000	96728·86	151·14	0·365

When the orders were received restricting the operations to Barkagarh, the Amins were already at work. This accounts for the area surveyed in Chota Nagpore.

In addition to the area given above, a skeleton traverse survey has been executed in advance over 132 square miles containing 146 villages. The general average size of fields includes large patches of forest. If these latter be excluded, the average size of fields in Barkagarh is only 0·319 of an acre, and

REVENUE BRANCH SURVEY OF INDIA.

INDEX MAP OF CHOTA NAGPUR AND BARKAGARH ESTATES, CADASTRAL SURVEY.


85°
85° 30'
23° 30'
N A G P U R
C H O T A
E S T A T E
H.S. 2601
Pitoria
Choria
Kutamkuli
Champarua
Nagri
Kaimla
Katanga
Sakarsuta
Nawa Katrampada
Turup
Hurel
Sailani
Mallong
Bongai
Kirkata
Dumartoli
Palandu
Ramgarh Hartoli
Sagud
Kharsawan
Kumardi
Dakatarh
Bunda
Kujaram
Karanchi River
Lambum
Nakadiha
Sarle
Sajahata
Dakar
Digadih
Sankartola
Kasundra
Kadli
Harlarpur H. S.
Ramgarh
Territola
Hatgaon
Khadara
Nagra
Nawadih
Kharsawan
Kolkata
Kasiajor
Nakapur
Sidhpur
Kanaidih
Kharsawan
Dhalbhum
Kharsawan
Sarai H.S.
Kharsawan
Kharsawan
Kharsawan

in Chota Nagpore ·194 of an acre; the rice fields in the latter averaging only ·084 of an acre.

After a lengthened correspondence with the Commissioner, it was decided that the "*kiarí*" was to be made the unit of measurement, excepting in the "buinhari" holdings, where congeries of fields were only required.

In executing the cadastral survey, the average measurements per acre made were 11·07 chains. Field operations were brought to a close at the end of May, recess operations being commenced at Hazaribagh on the 3rd June.

Check and verification of work.

281. Check azimuths have been observed at 19 stations, the observed meridian being in each case referred to "Hariarpur" station of the Great Trigonometrical Survey Calcutta Longitudinal Series, which has been adopted as the origin of survey. The initial azimuth was obtained by observation, which has been verified wherever possible by the sides of the triangulation. The rectangular co-ordinates of stations have, as a rule, been corrected to agree with the triangulation data. In some cases it was found that too great forcing would have resulted from so doing.

The main circuit traverse corrections have averaged 2·5 links in northing and southing, and 2·0 links in easting and westing per 100 chains.

The survey of every village has been checked by lines run either by a European Assistant, or by a Native Inspector, or by both. The total check lines aggregate 6,548 chains.

When the checks were run by the Inspectors, they were invariably on lines selected by the camp officer; and as they were only plotted in Office, the test may be said to be equally rigorous in either case. It was observed that, as a rule, the 16-inch work agreed better than the 32-inch work with the check lines.

Difficulties of survey.

282. Sickness was very prevalent throughout the whole field season. There were 323 admissions to hospital; many of the cases proving very protracted. Two Amins died, and many others had to be sent away unfit for duty. The very scattered nature of the work, the small size of the rice fields, the crooked boundaries, and undulating jungly country, have all added obstacles to quick progress. The greatest impediment, however, was the "buinhari" and other rent-free holdings: this is referred to in the Appendix.

Demarcations.

283. Although when field measurements were commenced in November 1877 there were no demarcations ready, I represented to the Commissioner of Chota Nagpore that, unless this was at once taken in hand, it would be incumbent on me to stop the survey operations, which, under the present state of things, must end in failure; they were then so vigorously pushed on, that but little real delay occurred, except in the case of about twenty disputed boundaries. In these, both boundaries were surveyed and referred to the Settlement Officer for decision; in all cases he was able to settle which boundary was to be upheld. Captain Sandeman states his indebtedness to Major Lowis, Manager of the Chota Nagpore Estate, and to Lieutenant Grey, Settlement Officer of Barkagarh, for their cordial co-operation.

Recess duties.

284. The Amins were required to send in their field sketch books to the camp office as soon as completed. From these the sheets were then plotted by a staff of plotters kept for the purpose. This system is perhaps a little more expensive than that of letting the Amín plot his work as it advances; but the advantages gained are undeniable, and more than worth the extra outlay. The season's mapping extended to 198 sheets on the 32-inch and to 324 on the 16-inch scales; these were pentagraphed down to 15 sheets on the 4-inch scale.

Permanent marks.

285. Throughout the whole of the operations there is not a single permanently marked point or station. The Settlement Department erected none, as is now almost universally done at the trijunction points of villages. The boundaries were marked by mud pillars only; the theodolite stations have been marked by burnt clay cylinders. These will at best last a few years only, when all hope of identifying them will have passed away. If the trijunction points were even now marked, much unnecessary labor and expenditure in the future might be

avoided. This is a point well deserving the consideration of the Board of Revenue.

Operations in prospect.

286. The plan of operations for this party was the completion of the Barkagarh and Chota Nagpore Estates; but in accordance with the orders of the Bengal Government conveyed under endorsement No. 2293, dated 20th September 1878, the operations in Barkagarh and Chota Nagpore have been now restricted to the following areas, *viz.*:—

In Barkagarh Estate.

	Area.
2 Mission villages, cadastrally	... 1,674 acres.
2 Incomplete khalsa villages, cadastrally ...	... 247 „
Skeleton traverse survey	... 17,200 „

In Patia and Selim Estates.

12 Villages, cadastrally	... about 19 square miles.

On the completion of the above during the present field season, the field work of this party will end.

Personnel.

287. Assistant Surveyor, Mr. D. A. King, is praised for the very satisfactory manner in which he has conducted the duties of a cadastral camp office. Mr. Parker is eulogised as being a hard-working and reliable assistant.

Sub-Surveyor Fussioodeen has especially distinguished himself by the manner in which he delineated the undulating ground on this large scale.

The season's outturn reflects credit on Captain Sandeman's management of a small party. He has worked it well; having obtained satisfactory results at a fair cost, when the difficult nature of the country and the minuteness of the fields are borne in mind.

This establishment was inspected by me in August at Hazaribagh. I found everything in excellent order; the work both of mapping and calculating being systematically carried out, and the duties of both the European and Native Assistants carefully supervised.

BOMBAY PRESIDENCY.

DECCAN TOPOGRAPHICAL SURVEY.

XII.—10TH DIVISION, REVENUE BRANCH.

POONA AND AHMEDNAGAR DISTRICTS.

288. The party took the field on 15th November 1877, under charge of Mr. G. H. Cooke, Assistant Superintendent, who was on 4th January 1878 relieved by Captain E. W. Samuells, Officiating Deputy Superintendent. Field work closed on 15th May 1878.

Duration of field season.

ESTABLISHMENT.

Captain E. W. Samuells, Officiating Deputy Superintendent, 3rd grade, from 3rd January 1878 to 11th September 1878.
Mr. G. H. Cooke, Assistant Superintendent, 2nd grade, in charge up to 2nd January 1878, and again in charge from 12th September 1878.

Assistants.

Mr. A. M. Lawson, Surveyor, 4th grade.
„ J. Newland, Assistant Surveyor, 1st grade.
„ G. C. Swiney, „ „ 2nd „
„ R. R. Dickinson, „ „ 4th grade.
21 Sub-Surveyors, &c.

289. The country brought under survey lies between parallels $\frac{18° 45'}{19° 30'}$ north latitude, and meridians $\frac{73° 30'}{75° 00'}$ east longitude, comprised in the 1 inch = 1 mile standard sheets 18, 19, 22, 23, 24, 28, in Talukas Khed and Junnar of Poona Collectorate and in Akola, Ahmednagar, Parner, and Shrigonda of Ahmednagar.

Limits of survey.

290. The area surveyed in detail amounts to 2,090 square miles, and triangulation was also extended over 2,525 square miles in advance for 1878-79. The scale of survey was, as heretofore, that of 2 inches = 1 mile. Every detail has been shewn that this scale admits of. Captain Samuells reports, that the village boundaries have all been surveyed and compared in Office with the Bombay Settlement maps. On level ground the two surveys agree very well, but in the hilly portions, and especially near the Ghâts, the Settlement maps could not possibly be utilised. Every plane-table section, where possible, was checked by a line of re-survey run through it (these aggregated 256 linear miles), and in the more hilly portions, where chaining was impracticable, by an examination of the board *in situ*. The result of the tests was most satisfactory, and showed the work to have been carefully executed.

Topographical Survey.

291. The skeleton survey was a combination of triangulation and traversing. The country was first covered by a net work of triangles, having sides averaging 10 miles in length. The distances between triangulated points were then traversed with the chain, thus enclosing main circuits, of which the bearings and co-ordinates obtained by traverse were corrected to agree with the values of the points derived from the triangulation.

System of survey.

292. In executing the triangulation, a 12-inch theodolite was used. In 102 angles, of which all the angles were observed, the average angular error was 7·8 seconds, and the average difference on comparison of 43 common sides was 3·3 inches per mile. In 116 triangles, of which only two angles were observed and the third deduced, the average difference on comparison of 53 common sides was 3·9 inches per mile. The triangulation was based on the Great Trigonometrical Survey sides—

Triangulation.

Wapgaon to Dighi	Singhi Series.
Wapgaon to Babulsir	
Parner to Babulsir	
Alsudi to Khanpisura	Khanpisura Series.
Khanpisura to Sowtara	

Connection was made with the triangulation of the 11th Deccan Party; the average difference in 8 common sides was 6½ inches per mile.

293. The centre of each degree has been adopted as the station of origin or point of departure for all the bearings and co-ordinates of stations falling within that degree.

Origin of survey.

The traverse survey executed with theodolite and chain included 8 main circuits, 4 sub-circuits, and 136 sub-divisional lines, aggregating 1,754 linear miles of traverse. The average angular error was 12½ minutes in 100 angles, and the linear correction applied was 3·3 links per 100 chains in latitude, and 2·8 links in departure.

294. Captain Samuells states that 71 heights have been determined trigonometrically, the average difference of common observations being only 2·8 feet. These heights mostly refer to triangulated stations, which are situated either on peaks of hills, or high ground. Additional observations will be taken during the ensuing field season to obtain the heights of Ghât passes, junctions of streams, principal towns, and other useful points. A list of bench marks was obtained from the Irrigation Department, some of which fell within the work; and where the sites of these could be identified, they have been noted on the maps. These levels have been connected with the Great Trigonometrical Survey leveling operations, so that their height above mean sea-level has been determined.

Heights.

295. The area surveyed has been mapped as usual on sheets 30' longitude by 15' latitude, traced from the original field sections on the scale of 2″ = 1 mile, and drawn suitably for photographic reduction to the scale of 1″ = 1 mile. Sheets Nos. 18, 19, 23, 24, situated within $\frac{19° 15'}{19° 30'}$ latitude, and $\frac{73° 30'}{74° 0'}$ longitude, are ready for despatch to Calcutta.

Maps.

296. The city of Ahmednagar has been surveyed on the scale of 66 feet (or 1 chain) to an inch for the Municipality, to whom the extra cost of the increased scale has been charged. The large scale was necessary, as the verandahs, projecting steps, drains, &c., required on the plan for municipal purposes could not have been clearly shewn on a smaller scale. The city was connected with the triangulation, and a station fixed on the roof of the city lock-up; it was then traversed and sub-divided into small blocks with the theodolite, plotted and mapped. Every house and building has been shewn and numbered. The area of the city within the walls is 317 acres.

City of Ahmednagar.

297. The usual skeleton charts, showing plotted stations, triple-junctions and boundaries of villages, and positions of main circuits, have been prepared for the Bombay Settlement survey, and will be furnished along with a copy of the traverse data.

Records for Settlement Survey.

298. Owing to the failure of the usual rains in 1876, the prices of grain of all kinds remained very high throughout the past season in the districts under survey, and though there was no actual scarcity, there was a good deal of distress here and there. This long continuance of famine prices pressed hard on the Sub-surveyors and Measurers, to whom it was, in consequence, necessary to grant a small increase of pay.

High prices.

299. Captain Samuells reports in high terms of all his Assistants. Mr. G. H. Cooke, who held charge of the party till the beginning of January 1878 and started the work, exercised excellent control over his camp. Mr. Lawson turned out a capital survey of the rugged and difficult country along the ghâts. Mr. Newland, who was entrusted with the triangulation, is a very accurate observer, hard-working and energetic. Messrs. Swiney and Dickinson have also done good work in field and recess.

Personnel.

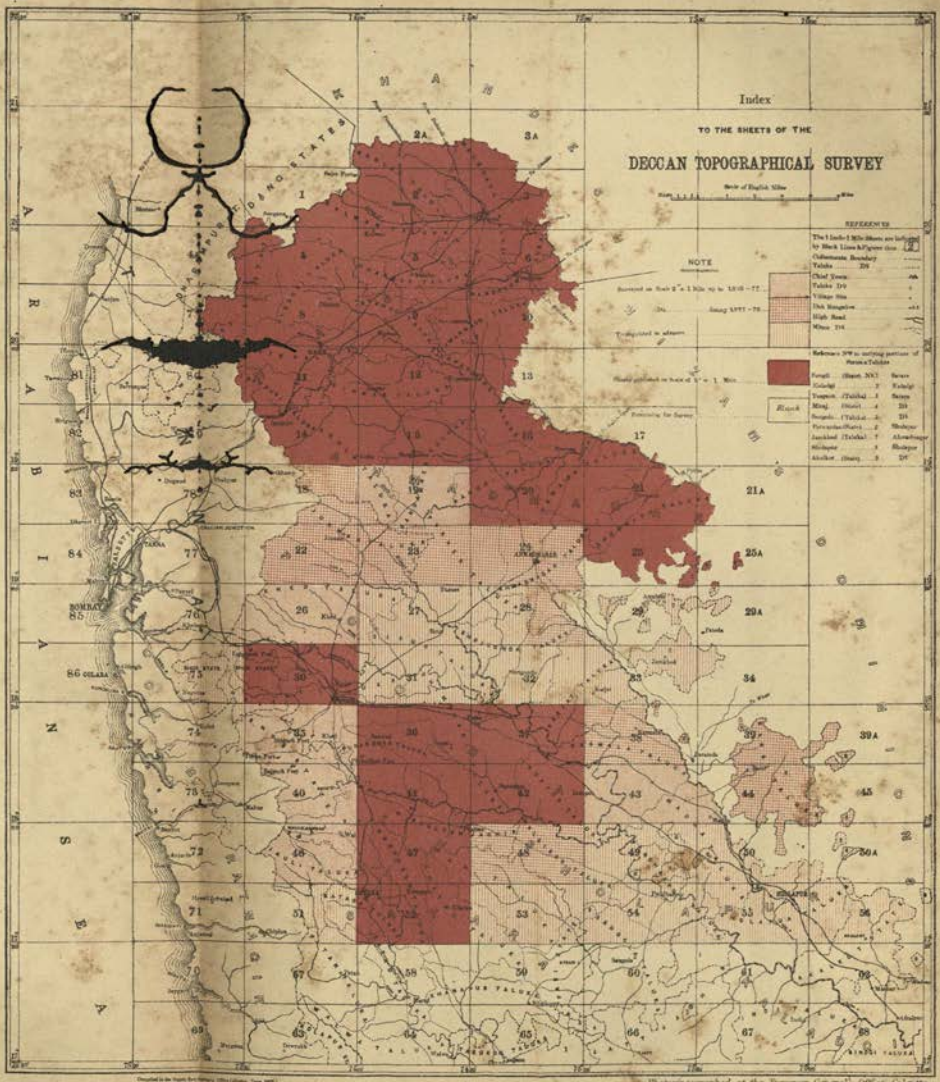
300. The area remaining for detail survey down to the parallel of 18° 30', which is the line common to the 10th and 11th Divisions, is estimated by the Surveyor at 3,000 square miles, the whole of which has been triangulated in advance. Of this area, it is calculated that about 2,000 square miles will be completed during 1878-79, leaving only half a season's work for 1879-80, unless a new field is meanwhile decided on.

Future operations.

301. In the Appendix will be found an interesting description of the country surveyed during the season 1877-78.

Descriptive report.

REVENUE BRANCH SURVEY OF INDIA



Photozincographed at the Surveyor General's Office, Calcutta.

Published under the direction of Colonel J.T. Walker C.B. R.E. F.R.S., Surveyor General of India.

Surveyor General's Office, Calcutta. January

XIII.—11TH DIVISION, REVENUE BRANCH.

POONA, SATARA, AND SHOLAPUR DISTRICTS.

Duration and extent of work.

302. This party, under Major H. C. B. Tanner, Deputy Superintendent, took the field towards the end of November, 1877, and closed work at the end of May 1878. The survey extended to Sheets 26, 38, 39, 39A, 44, 45, 46 and 48, and comprised an area of 2,423 square miles, which was completed in detail, on the scale of 2 inches to a mile, as in preceding seasons.

ESTABLISHMENT.

Major H. C. B. Tanner, Deputy Superintendent, 3rd grade.

Assistants.

Captain H. S. Hutchinson, Officiating Assistant Superintendent, 1st grade.
Mr. S. M. Smylie, Surveyor, 3rd grade.
„ T. W. Reilly, Surveyor, 4th grade, transferred to Head-quarters' Office, Calcutta, from 18th July 1878.
„ J. T. U. Coxen, Assistant Surveyor, 2nd grade.
„ W. H. Penrose, Officiating Assistant Surveyor, 2nd grade.
„ C. T. J. Dease, „ „ „ 4th grade, permitted to resign from 27th July 1878.
18 Sub-Surveyors, &c.

Triangulation.

303. The interior survey was, as before, based on triangulation and traverse. The area in advance covered by triangulation executed during the season, amounts to 1,620 square miles, fixing 90 points. The table below gives the number and classification of the triangles:—

Triangles.	Number.	In error.	Error of common sides in inches per mile.
1st Class	2	4"·5	...
2nd „	2	2·5	0·8
3rd „	13	6·1	4·7
4th „	180	...	5·0

Heights.

304. Major Tanner states that—

"180 deductions of heights have been computed, fixing the altitude of 86 points. At the close of the season we received the true height above mean sea-level of a number of points obtained by Captain Baird of the Tidal and Leveling Party, and this has enabled me to reduce a number of the irrigation levels to their true height above sea. I have to express my thanks to the Executive Engineers for Irrigation for the assistance they have afforded me in placing their levels and charts at my disposal. From the charts we have been able to cover our sheets with bench marks, and our maps are now an excellent index to the operations carried on by the Irrigation Department in the central parts of the Deccan for many years past."

It is very satisfactory and creditable to all concerned, that the deduction of the height of the bench mark at Satara church is found to differ by only 2 feet from the true height now determined by the leveling operations carried on by Captain Baird of the Great Trigonometrical Survey.

Check Survey.

305. The Topographical Survey was tested by 223 linear miles of check survey run through the plains portion of the work, which was found accurate; only small portions required re-survey. The mountainous parts were well checked by examination *in situ*.

Bombay Survey Maps.

306. During the season under review, Major Tanner was able to turn the Bombay Revenue Survey maps to good account. He observes that—

"in the plains we have utilised the topography of about two maps out of three, and as we work southwards and get into a better class of work, I fully expect that we shall be able to use three out of four, or even more."

As regards the test applied to the Bombay maps, he continues—

"the system we find to answer best is simply, first, to test the exterior limits of the village plan by measurements taken from our plots, and then, should the error be small, to put it on a plane-table and complete the topography; setting up the table on the trijunction of fields, and either intersecting the required items, or measuring them with offset rods. The information thus obtained is entered in red on the village plan, and the whole is then reduced

with a pentagraph * * It is found that such items as touch the boundaries of fields are almost invariably correct, and only such as fall within the field itself are liable to error. In the case of hilly and rough ground, we reject the Bombay plans and survey the tract ourselves."

Municipal Towns.

307. The municipal towns of Jejuri, Baramati, and Indapur, of the Poona District, have been surveyed on the large scale of 24 inches to a mile at the expense of the municipalities. Every house has been shewn on these maps; but, notwithstanding the large scale, the reference numbers of many houses cannot be entered. The Collector of Satara has, consequently, asked Major Tanner to survey all municipal towns in his district on the increased scale of 80 inches to a mile (or 66 feet to an inch); and this scale has been adopted for Malcolm Pét (Mahableshwar Bazar). The city of Satara is also being surveyed on this scale. Each sheet of a municipal map is the size of a plane-table, and all topography outside the towns, falling within the plane-table, has been mapped to margin. Thus the area embraced by the large scale exceeds the actual limits of the municipality, as will be seen by Major Tanner's statement below :—

Towns.	Area of Municipality.	Area of Map.
Jejuri	97·5 acres	227 acres.
Indapur	146·5 „	147 „
Baramati	126·5 „	154 „
Malcolm Pét	28.5 „	112 „

Personnel.

308. Major Tanner expresses his complete satisfaction with the conduct and exertions of his Assistants. He especially notices Captain Hutchinson, Assistant Superintendent, and Mr. Smylie, of whom he entertains the highest opinion. Mr. Reilly has also done very good work; "the finish of his maps is excellent." Mr. Coxen has been steady; and Mr. Penrose is mentioned as a very capable Assistant.

Future operations.

309. During 1878-79, the work will progress southwards in Districts Sholapur and Satara.

ASSAM.

XIV.—LAKHIRAJ SURVEY, REVENUE BRANCH.

District Kamrup.

Procedure described.

310. Work was resumed by Mr. W. H. Patterson and his small party in Dstirict Kamrup early in November 1877, and closed about the end of May 1878; the object of the survey being to ascertain the areas of plots of lands held by the lakhirajdars, preparatory to adjusting their claims and allotting what they are actually entitled to. An Extra Assistant Commissioner is specially appointed to aid the survey. It is this officer's duty to make preliminary enquiries into claims; after the claims are admitted, the Extra Assistant Commissioner marks off approximately on the ground the plots to be surveyed. Sometimes these plots are according to possession, but in most cases the lakhirajdars agree to give up all the smaller isolated patches of land, and in lieu of them to take the area they are entitled to in one compact block. The Extra Assistant Commissioner in marking off these consolidated plots makes no survey, the temporary marks put up serve only as a guide to the survey parties. Within these limits the professional Surveyor has, in the first place, to make a detail survey (on the scale of 8 inches to a mile), secondly, to adjust the boundaries according to the area to which the lakhirajdars are entitled: when the areas and boundaries have been adjusted on the interior survey plans, the final demarcation is then made, and the boundaries are surveyed and recorded by field book. The work may thus be briefly described, as consisting of three stages, *viz.*:—

Mr. W. H. Patterson, Surveyor, 1st grade.
11 Sub-Surveyors, &c.

1*st.*—The professional survey of interior details.

2*nd.*—The adjustment of areas and boundary.

3*rd.*—The final demarcation and boundary survey.

Outturn.

311. In estimating the season's out-turn, it must be remembered that the actual area surveyed is no index of the work done. Mr. Patterson explains that much of his time is taken up in adjusting boundaries, and that half the time of the boundary Surveyors is occupied in putting up the marks along the boundaries before they are surveyed; thus the work is altogether of a very desultory nature, where much time is unavoidably wasted in marching and in going over the same ground several times.

1st. Interior survey.—In North Kamrup, 72 estates, la-khiraj (rent-free) and nisfi-khiraj (half-rent-paying), were surveyed, as detailed below:—

Names of Mouzas.	Nos. of Estates.	Area in Acres.	Square Miles.	Remarks.
Betna	1	46·80		
Pati Darrang	7	2067·10		
Pub-Kachari Mehal	7	329·30		
Bor Bangshar	2	308·10		
Pubpar	10	667·60		
Madartola	4	124·70		
Total	31	3543·60	5·54	

Additional area to plots surveyed in 1875, 1876, and *1877.*

Names of Mouzas.	Nos. of Estates.	Area in Acres.	Square Miles.	Remarks.
Betna	1	63·90		
Pati Darrang	17	264·95		
Pub-Kachari Mehal	2	4·40		
Bor Bangshar	11	215·75		
Madartola	10	85·50		
Total . .	41	634·50	0·99	
Total of Interior Survey . .	72	4178·10	6·53	

2nd. Adjustment of Areas and Boundary.—The areas of 151 estates, situated in six mouzas, were adjusted. Mr. Patterson remarks—

"for this work, upwards of 200 notices had to be served on the lakhirajdars to secure their personal attendance at the Survey Office. The areas marked off by the Extra Assistant Commissioner being only approximate, numerous alterations of boundary were necessary before the final boundary survey could be proceeded with. As a rule, the area marked off is found to be in excess; but as the area to be left in each estate depends on a certain classification of details, such as cultivation, village site, and waste (based on the Collector's register), much time is taken up in shifting about the boundary line until the total area with details comes correct, or nearly so, up to the margin of 10 per cent. area conceded by the Government of India; the adjustment has, therefore, to be done with great care, and entails several sets of detail calculations (on the plans) before the boundaries are finally fixed. When the area has been adjusted and the proper lines of boundary determined, the plans are submitted to the Deputy Commissioner (as Collector of the District) for confirmation of the altered boundaries. The plans of the past two seasons have been approved and countersigned by the Deputy Commissioner."

3rd. Final Demarcation and Boundary Survey.—The following estates, of which the interior survey was made in 1875-76-77, were completed in boundary:—

Names of Mouzas.	Nos. of Estates.	Area in Acres.	Remarks.
Bor Bangshar	46	3206·11	Mouzas Betna and Pub-Kachari Mehal are completed, but in the rest some holdings still remain, and will be taken up during 1878-79.
Betna	9	561·15	
Kaurbaha	6	1924·96	
Madartola	27	1133·59	
Pati Darrang	74	9177·66	
Pub-Kachari Mehal	28	2256·38	
Total . . .	190	18259·85	

Boundary marks.

312. The number of permanent and temporary marks put up by the Surveyor during the season amounted to 1,935, of which 924 were stone, 10 sâl posts, and 1,001 earthen mounds; these alone represent a large amount of work in the field: the stone prisms are purchased in Calcutta. The cost of demarcating lakhiraj and nisfikhiraj holdings is recoverable from the proprietors of estates, and the Deputy Commissioner is furnished with lists, according to mouzas, of the number of marks put up on each lakhiraj plot of which the final demarcation has been completed.

313. The maps of the season consist of 7 skeleton sheets, on scale of 4 inches = 1 mile, containing boundaries and names of lakhiraj estates, which have also been entered by Mr. Patterson on the 4 inch atlas sheets of the Kamrup District Survey.

Maps for the Deputy Surveyor General's Office.

314. The Deputy Commissioner has been supplied with 3 volumes of original plans of 233 lakhiraj estates, scale 8 inches =1 mile, with lists of their areas in acres and bigahs. He has also been supplied with copies of 317 plans of estates for lakhirajdars, and skeleton maps by mouzas of 233 lakhiraj holdings, showing the boundary marks put up, on scale 4 inches = 1 mile, for the use of the mouzadars.

Maps for Civil Authorities.

315. All the stone marks on boundaries were adopted as theodolite stations. Three stone pillars, Nos. 33, 86 and 87, put up in 1873-74 on the common boundary of Districts Darrang and Kamrup, were also connected by traverse. The several detached holdings were connected by traverse and then plotted on the congregated village sheets of the first survey of the district on the scale of 4 inches = 1 mile. The number of chains measured for the traverse survey aggregates 331 linear miles.

Traverse survey.

316. Under sanction of the Supreme Government, this party has been recently strengthened by the addition of 1 Assistant Surveyor, 10 Sub-Surveyors, &c. The work in District Kamrup may, it is now hoped, be completed in season 1881-82.

Party increased.

317. It is gratifying to add that the Deputy Commissioner (Colonel Lamb) has materially aided survey operations; owing to his influence the mouzadars, with but one exception, were found attentive to the requirements of the survey. The whole establishment worked in harmony with the people of the district throughout the year.

Relations with Civil Authorities.

318. Great delay continues to occur owing to the difficulty experienced in getting the lakhirajdars to attend when required; on representation to the Deputy Commissioner, nine were fined in season 1876-77, and six in the past season. Their attendance is necessary, as their consent has to be obtained before the boundaries can be altered, when the area is found either in defect or in excess of the authorized grant.

Obstructions to progress.

Unfortunately for the survey interests, the same mookhtear or agent is appointed for several estates. This causes additional delay and was accordingly referred to the Deputy Commissioner, who stated that the difficulty could not be remedied, as the lakhirajdars must be permitted to choose their own representatives.

D. C. VANRENEN, *Major General,*
Deputy Surveyor General,
Superintendent, Revenue Branch.

Calcutta, December 1878.

Table A.

General Return of Professional Work for Season 1877-78, exhibiting Area and Cost of the North-Western Provinces, the Punjab, Lower Provinces, and Bombay, from 1st October 1877 to 30th September 1878.

Province.	Survey Division.	District.	Scale.	Number of traversed circuits and fields.	Area. Completed in detail.	Area. Village Boundary Survey in advance.	Linear miles of Check Survey.	Total Cost, exclusive of charge for Levelling.	Average Rates.	Average size of Fields.	Remarks.
				CADASTRAL SURVEYS.							
				Villages. Field.	Acres.	Square Miles.		Rs. A. P.	Per acre. Rs. A. P.	Acres.	
North-Western Provinces	4th Division	Moradabad (mapping)	16″ = 1 mile	... ...	...	...	...	30,465 15 3	...	...	
	5th do.	Banda	,,	298 263,614	388,163	202	1,448	1,27,092 2 4	0 5 3	1·05	The rate includes Rs. 14,771-15-5 for preparing transfer traces and bringing up arrears of mapping.
	6th do.	Jaunpur	,,	216 290,540	96,505	103	392	49,225 8 11	0 8 2	0·32	The rate is exceptional, this being the first season in a new district, in which operations were necessarily commenced at a late date.
	Chota Nagpur Division	Chota Nagpur Estate	,,	6 }	4,800(a) }	152	82	6,852 1 6	0 8 5	...	(a). Exclusive of the area partially surveyed during the previous season, alluded to in para. 2-9 of this Report.
		Barkagarh ditto	,,	61 } 170,817	64,859 }			31,798 10 5			
		TOTAL	...	600 838,671	558,327	537	1,932	2,45,444 6 5	0 6 2*	0·66	* The rate is exclusive of Moradabad mapping cost.
Bengal	7th Division	Poorce, Khoorda Estate	32″ = 1 mile	247 512,131	160,045	160	516	1,07,272 0 1	0 10 9	0·31	
	8th do.	Shahabad	,,	298 302,407	92,969	... }	517	1,39,145 6 3	0 10 3	0·30 }	The rate includes Rs. 14,895 for Shahabad, and Rs. 8,774 for Patna for preparing transfer traces and extra copies of khasra and area Statements, &c.
		Patna	,,	465 377,541	124,785	... }				0·33 }	
	9th do.	Cuttack	,,	147 246,136	43,412	216	211	65,707 10 10	*	0·18	* The rate, if recorded, would be altogether fallacious, this being the first season, with a new establishment in a new district, in which operations were necessarily commenced at a very late date.
		TOTAL	...	1,167 1,445,215	421,211	376	1,274	3,12,125 1 2	0 10 5	0·29	
				ORDINARY VILLAGE AND TOPOGRAPHICAL SURVEYS.							
					Sq. miles.	Sq. miles.			Per Sq. mile.		
Punjab	1st Division	Dera Ismail Khan	4″ = 1 mile	.....	.....	2,696	.....				
		Bannu	,,	348 Traversed Circuits	1,203	b 1,025 }	90	89,951 3 2	48 7 0		Including 50 square miles of overlap (4″ scale) on independent hill territory, and 57 square miles within District Bannu surveyed on 16″ scale.
		Rawalpindi	,,		404	f 202 }					
		Jowaki country	,,	Topographical	210	.....	.....				
	2nd do.	Sirsa	,,	317 Villages	1,791	1,383	525	61,098 2 6	34 6 3		Including 188 square miles of overlap (4″ scale) on adjoining districts.
North-Western Provinces	3rd do.	Saharanpur	2″ = 1 mile	Topographical	850	900	317	52,669 10 5	.....		Cost includes expenditure on Dearah Survey during October and November 1877. The rate, if given, would be fallacious.
	4th do.	Budaun	4″ = 1 ,,	1,346 Villages	1,110	.....	301	49,942 8 5	44 15 11		Inclusive of 185 square miles of river and 33 square miles of overlap on adjoining districts.
Bombay	10th do.	Ahmednagar and Poona	2″ = 1 ,,	Topographical	2,600	f 2,525	226	53,191 2 9	20 6 6		
	11th do.	Poona, Sholapur, and Satara	2″ = 1 ,,		2,423	f 1,620	223	61,031 5 10	25 3 0		
	8th do.	Shahabad (River area)	4″ = 1 ,,	,, ...	55	.....	.....	2,900 11 0	52 11 10		
	5th do.	Native States (in Banda)	,,	,, ...	110	.....	.....	*	.....		* Cost included in Banda District Survey.
	Detached party	Midnapur (*Vide* para. 128 of Annual Report for 1876-77)	1″ = 1 ,,	,, ...	44	.....	.....	12,635 7 2†	.....		This amount includes cost of bringing up arrears of mapping, revision of village boundaries and areas, arrears of leave pay to Sub-Surveyors, and contingent expenses of the party to and from Midnapur. No rate can therefore be struck on the area surveyed.
		TOTAL	...	...	10,342	b 6,003 } f 4,387 }	1,712	5,83,831 4 3	42 7 4		for 4″=1 mile.
									25 4 7		,, 2″=1 mile.
		GRAND TOTAL	...	.....	31,972	b 6,003 } f 4,387 }	4,916	84,500 11 10			Note.—b. stands for boundary survey in advance. f. ,, for triangulation ,, ,,

Table A—(*concluded.*)

Abstract according to Jurisdictions.

No. of Parties.	Jurisdiction.	Scale of Survey.	Area surveyed in		Total Cost.	Average rate.	Remarks.
			Acres.	Square Miles.			
					Rs. A. P.	Rs. A. P.	
2	Punjab ... ... { Mouzawar ... ... / Topographical	16″=1 mile 4″=1 mile 4″=1 mile	36,480 1,869,120 311,040	57 3,108 486	1,51,649 5 8	41 8 7	Per square mile.
4	North-Western Provinces ... { Cadastral ... ... / Mouzawar ... ... / Topographical	16″=1 mile 4″=1 mile 2″=1 mile	484,608 786,560 544,000	757 1,229 850	2,06,793 10 6 49,942 8 5 52,650 10 0	0 5 0 44 15 11 *	Per acre, exclusive of Moradabad mapping c Per square mile. * *Vide* remark against Saharanpur.
4	Bengal ... ... { Cadastral ... ... / Topographical	32″=1 mile 16″=1 mile 4″=1 mile 1″=1 mile	421,111 73,639 33,200 28,160	658 115 55 44	3,12,125 1 2 38,650 11 11 2,900 11 0 12,636 8 2	0 10 5 0 8 5 53 11 10 †	Per acre, exclusive of Cuttack Survey. „ „ Per square mile. † *Vide* remark against Midnapur.
2	Bombay ... ... Topographical	2″=1 mile	2,888,320	4,513	1,14,133 8 7	25 4 7	„ „
12	TOTAL	.....	7,593,288	11,872	9,41,600 11 10	.....	

Districts completed since last Report.

Districts.	Scale.	When commenced to be surveyed.	When finished.	By whom surveyed.	Area in		Cost inclusive of contingent expenses.	Rate per square mile and acre.	Remarks.
					Acres.	Square miles.			
							Rs.	Rs. A. P.	
Budaun	4″ = 1 mile	1875-76	1877-78	Captain W. Barron	1,302,793	2,036	1,11,064	54 8 9	Per square mile. The general average rate is higher than that of 1877-78, owing to the exceptionally high rate of the first season 1875-76.
Midnapur (including 400 sq. miles of Balasore)...	4″ = 1 mile 1″ = 1 mile	1872-73	1877-78	Lieut.-Col. Macdonald, Major Sconce, Captains Wilkins and Sanderson, Messrs N. T. Davey, W. Lane, and F. W. Kelly.	3,252,733	5,129	3,16,072	61 10 0	Per square mile.
Behar Irrigation Survey (Cadastral)	32″ = 1 mile	1874-75	1877-78	Lieut.-Col. Oakes, Major Sconce, and E. T. S. Johnson, Esq.	1,184,296	1,850	5,88,173	0 7 11	Per acre, including cost of traces and extra copies of area statements for Irrigation Branch.

DEPUTY SURVEYOR-GENERAL'S OFFICE,
Calcutta, the 10th January 179.

F. CODDINGTON, *Major,*
Deputy Superintendent at Head-Quarters.

Table B.

Abstract Statement of work performed in the Drawing Branch of the Office of Superintendent, Revenue Branch Survey of India, from 1st January to 31st December 1878.

Maps.	Scale.	Remarks.
PUNJAB.	Inch Mile.	
District Rohtak, in 8 sheets, 30′ × 15′.	1 = 1	Drawn by the Surveyor, examined and completed for publication in Head Office, and sent to photo. press.
District Rohtak, preliminary map and sheet index ...	½ = 1	Drawn for photo. reduction to half scale, and sent to press for publication.
NORTH-WESTERN PROVINCES.		
District Agra, in 10 sheets, 30′ × 15′.	1 = 1	Blue prints, 2″=1 mile of Sheets 2, 5, 6, 8, 9, completed and sent to press for photo. reproduction and publication on scale 1″=1 mile. The district is now out of hand.
District Agra, preliminary map and sheet index	½ = 1	Completed and sent to press for photo. reproduction to scale, and publication.
District Hamirpur, in 12 sheets, 30′ × 15′	1 = 1	Blue prints. 2″=1 mile, of Sheets 3 to 12, completed, examined, and sent to press for photo. reduction, and publication on scale 1″=1 mile. The district is now out of hand.
District Hamirpur, preliminary map and sheet index.	½ = 1	Examined and sent to press for photo. reproduction to scale, and publication.
District Muttra, in 7 sheets, 30′ × 15′	1 = 1	Graticule lines ruled on 40 congregated village sheets 4″=1 mile, comprising 1″ =1 mile standards No. 1, 3, 5, 6, 7, and sent to press for reduction to half scale, to be re-drawn on blue prints for publication on 1″=½ mile scale.
BENGAL.		
District Midnapur, in 17 sheets, 30′+15′	1 = 1	Blue prints, 2″=1 mile of Sheets 2, 13, 12, 16, drawn, but cannot be completed pending revision of boundaries; Sheets 6, 9, 13, 15, 17, in different stages of advancement. The sheets including the jungle mehals have been mapped by the Executive Officer on the scale of survey 1″= 1 mile, but have to be completed up to margin and examined for press.
District Malda, in 7 sheets, 30′ × 15′	1 = 1	Graticule lines ruled on 1″ maps, previous to re-drawing in standards up to margin for lithography. Drawing in hand.
District Rajshahye, in 11 sheets, 30′+15′	1 = 1	Skeleton charts ruled in 5′ squares, groups of villages outlined, and 5′ squares also entered on the original 1″ maps for lithography.
District Furreedpore, in 13 sheets, 30′ × 15′	1 = 1	Ditto ditto ditto.

Table B.—(*contd.*)

Maps.	Scale.	Remarks.
Bengal.—(*contd.*)	Inch. Mile.	
Hooghly River,—adjoining Districts Hooghly and Midnapur ...	4 = 1	Sheets 18, 19, 20, 21, drawn for photo. reproduction to scale and sent to press for publication (in continuation of the series already published), showing the river and topography on each bank, as far south as Calpi. The sand-banks, soundings, marine marks, tide-gauges, &c., have been inserted from the latest marine charts.
Silchar Cantonment and Civil Station, District Cachar ...	12 = 1	Re-drawn with Deputy Commissioner's corrections of boundaries and additions of new buildings up to date, and sent to press for photo. reduction to ½ scale for publication.
Central Provinces.		
Pargana Dongurthal, District Nagpur	1 = 1	Original map examined, touched up and re-typed for photo. reproduction to scale, and publication for the use of the Forest Department.
Bombay.		
Deccan Topographical Survey 2″ = 1 mile, extending down to 17° latitude, and including the Konkan, 96 sheets, 30 × 15′	1 = 1	The original sheets received from Executives, drawn on scale of survey (2″ = 1 mile) are all carefully examined in the Head Office, touched up, and completed for photography before being sent to press for reduction to 1″ = 1 mile scale for publication. The number of sheets has been increased to 96 by the addition of the Konkan, between the ghâts and the sea.
Number of sheets published to date 31 „ under examination for press ... 9		
Total received to date ... 40 Number remaining ... 56		
Index Maps.		
District Dera Ismail Khan ...	On various scales.	Explanatory of the areas completed and remaining for survey in the several districts, for publication with the Annual Report for 1877-78.
„ Bannu		
„ Rawalpindi		
„ Sirsa		
„ Saharanpur		
„ Banda		
„ Jaunpur		
„ Pooree, Khorda Estate ...		
„ Cuttack		
„ Shahabad		
„ Gya		
„ Patna		
Deccan Topographical Survey ...		
Chota Nagpur Estate		

Table B,—*contd.*

Maps.		No. of Sheets.	Remarks.
Original maps of the Cadastral Surveys examined, touched up, rendered suitable for photography and sent to press		3,253	N.-W. Provinces, 16″ = 1 mile.
Proofs examined, field by field, for publication ...		3,182	
Five copies of each printed map received from press, colored by extra draftsmen, but examined in Office, for the Board of Revenue		17,925	
Proofs examined, field by field, for publication		6,433	
Four copies of each printed map received from press, colored by extra draftsmen, but examined in Office, for Superintending Engineer, Soane Circle ...		26,952	Behar Irrigation, 32″ = 1 mile.
Proofs of photozincographed maps ...	87	172	Miscellaneous maps, colored and examined with originals, &c.
„ lithographed „	85		
Issued (uncolored) on service		3,606	
For record in Surveyor-General's Office ...	131	2,632	
„ „ in Revenue Branch	131		
„ despatch to India Office	1,060		
„ issue to Government officials ...	1,310		
Boundary between Districts Partabgarh and Jaunpur, for Deputy Superintendent of Survey, 6th Division		1	Tracings on cloth
Boundary between Districts Fyzabad and Jaunpur, for Deputy Superintendent of Survey, 6th Division ...		3	
Maps of main circuits, 4 and 8, of District Akyab, for Superintendent of Telegraph Workshops ...		2	
Tract of country, District Peshawur between Aimal, Chabutra and Shumshuttoo, and between frontier road and base of frontier hills, for Deputy Superintendent of Survey, 1st Division		1	
Copies of Pargana maps, villages, grants, jagirs, boundaries, and 2″ survey of the Peint State in the Deccan, were made for Civil Officers on payment, but examined during Office hours ...		138	Extra work done for Government officials.
Copies of 389 traverses and 676 village plans ...		.....	For landholders.

Computing Office.

Examination of work.—The main circuit and village traverses and computations of the following divisions were examined and reviewed during the year :—

2nd or Rohtak	District	for season	1875-76.
7th or Hamirpur	„	„	1874-76.
12th or Midnapur	„	„	1875-77.
14th or Ganges Dearahs	„		1875-77.
Dhanwar Estate	„		1875-77.

Latitudes and Longitudes.—Longitudes and latitudes of the necessary survey stations were computed with the aid of Colonel Walker's Auxiliary Tables, for the purpose of laying down graticule lines on the 1″ maps of Districts Maldah, Moorshedabad, Dinajpur, Rajshahye and Furreedpore.

Miscellaneous.—Inserted survey stations and their co-ordinate values on the 1″ = 1 mile standard sheets of Districts Karnal and Bilaspur and the Bhawalpur State for compilation in the Surveyor-General's Office. Revised area of District Kamrup according to new limits. Prepared an area statement of District Rohtak. Re-calculated and revised the areas of about 400 villages of District Midnapur to correspond with alterations made by civil authorities in boundaries subsequent to survey. A large amount of other miscellaneous and desultory work, including copies of traverse data, &c. &c., was done during the season, which it appears unnecessary to detail.

Receipts.—The payment for extra work amounted to Rs. 2,159, of which Rs. 300-4 have been credited as fees to Government on maps and data supplied to landholders and non-official public.

F. CODDINGTON, *Major*,
Deputy Superintendent at Head-Quarters.

Deputy Surveyor General's Office,
Calcutta, 10th January 1879.

Table C

Tabulated Statement of the principal records prepared in the several Executive Offices of the Revenue Branch for the year ending 30th September 1878.

Province.	Survey Division.	District.	For Deputy Surveyor-General's Office.											For Settlement Department.		Remarks.
			Cadastral.			Atlas Sheets, 4-inch.	Quarter Sheets, 2-inch. or Standard 1-inch. Maps.	Triangulation Charts and Index Maps.	Area Traverses.		Field Books.		Original Field Plans.	Traces of Sheets.	Khasra Field Area Statements.	
			Sheets.	Amin's Field Sketch Books.	Field Area Statements.				Main Circuits with Azimuth Computations.	Village or Sub-Circuit.	Main Circuit.	Village or Sub-Circuit.				
			No.	Vols.	Vols.	No.	No.	No.	Vols.	Vols.	Vols.	Vols.	No.	No.	Villages.	
								CADASTRAL SURVEYS.								
N.-W. Provinces.	5th	Banda . . . . 16″	705	Not known.	Not known.	27	...	1	1	...	3	Not known.	...	357	298	
	6th	Jaunpur . . . 40″	270	30	4	41	...	1	3	3	3	16	...	114	215	
Bengal	6th Detached.	Gya and Patna . . 32″	896	30	36	16	...	1	3	3	3	14	...	...	465	
	7th	Poorea, Khorda Estate 32″	1,209	247	247	30	...	1	2	3	2	100	...	4,209	247	Also 84 repeat traces.
	8th	Shahabad . . . 32″	653	226	43	51*	...	1	2	7	2	42	...	...	298	* Includes previous seasons.
	9th	Cuttack . . . 32″	361	24	12	None.	...	1	1	2	8	8	...	142	142	Also 147 khasras for Collector.
	...	Chota Nagpur Estate . 32″ 16″	159 32	10	2	15	...	1	2	1	1	1	....	138	101	
			Triangulation.					VILLAGE AND TOPOGRAPHICAL SURVEYS.								
			Horizontal and Vertical Angle Field Book.	Triangle Computation.	Computation of Heights.										Detail Areas, Villages.	
Punjab.	1st	Dera Ismail Khan & Bannu	2	1	Not known.	...†	...	11	1	3	2	3	90— 4″ 41—16″	42— 4″ 26—16″	...	Also 10 maps of Sheikh Budin Sanitarium and 1 pu tal sheets
	2nd	Sirsa	...	...	...	...†	6	1	1	4	1	4	70	63	314	† The field sheets of th 1st and 2nd Division are submitted as fin Atlas Sheets.
N.-W. Provinces.	3rd	Saharunpur . . .	...	...	...	...	10	1	2	4	5	15	94	7	...	
	4th	Budaun	...	...	...	42	...	1	1	4	1	5	102	84	...	
Bombay	10th	Poona and Ahmednagar .	1	1	Not known.	...	16	2	1	1	1	6	35	...	...	
	11th	Poona, Sholapur & Satara .	Not known.	Not known.	Not known.	...	7	2	1	1	4	14	28	...	...	Also 5 maps of Municipal Towns.

Deputy Surveyor General's Office;
Calcutta, the 10th January 1879.

F. CODDINGTON, *Major*,
Deputy Superintendent at Head-Quarters.

APPENDIX.

EXTRACTS

FROM

THE NARRATIVE REPORTS OF THE EXECUTIVE OFFICERS

IN CHARGE OF

THE SURVEY PARTIES AND OPERATIONS.

Extract from the Narrative Report, dated 17th September 1878, of CAPTAIN M. W. ROGERS, R. E., *Offg. Deputy Superintendent, 3rd grade, in charge of the Eastern Sind Series.*

1. Several route sketches have been executed of the country along the Bolan and towards Khelat; these are confessedly inaccurate, being done mostly with prismatic compass and pacing. Hilly country, where from elevated peaks a general idea of the ranges, &c., can be obtained, is most favourable for this style of work, which will always have attractions for officers who may find themselves on duty in a comparatively unknown country, and who have a natural inclination for the work; but maps thus produced have no connection with the general map of India, and no amateur efforts can, in the case of the Bolan and the Khelat-Quetta country, give that connection.

The 120 miles of flat, and in many cases perfectly desert country, which lies between Jacobabad and Dadur, cannot be crossed except by a regularly-organized survey party working on strict rules.

2. The progress this year was slow, as no commencement could be made until I had been able to form some idea of the country, but I trust that I may be authorized to carry the triangulation on, at least as far as Quetta. Its permanent marks will remain for reference and be the reliable starting points for any extension of the survey which may be thought fit from time to time.

3. I deputed an assistant to perform the rather tedious and laborious work of carrying the triangulation from the Indus series to our frontier, and I employed myself in examining the country between the frontier and the hills. It is flat, with a gentle slope upwards to the hills, which rise very abruptly from the plain, presenting an almost inaccessible steeply scarped front, broken up only at the entrance of the Moola Pass. There is a great dearth of water and vegetation towards the British frontier, but there are many ravines and water-courses near the hills. The soil is a stiff clay, and, judging from the cultivation where there is water, it is fertile. There are several considerable villages, notably Gundáva and Bágh, and the ruins of many others bear testimony to much greater prosperity and population than there is at present. The causes of this depopulation, from what I could gather, are three-fold,—failure of water, grinding taxation and oppression on the part of the Khans of Khelat, and forays of the Marris and Bugtis.

4. A curious formation of clay hills skirts the foot of the northern portion of these hills, and stretching across the angle formed by the Khelat and Marri Hills (into which the Bolan Pass opens) forms the valley of Dadur and boundary of the Sibi plain.

These hills are of friable clay, and seem to have been much acted on by the rain; they stretch in parallel ridges, being upheaved at an angle of about 20 °; the scarp being to the east, their height being from 50 to 400 feet, and in parts the clay is indurated into something nearly resembling stone, but which is easily broken up; bands of pebbles run through them, and talc is found in some quantity.

5. The higher hills in the Bolan appear to be a conglomeration of stones and rocks, large and small, bound together by clay; and the slopes, which are often very steep, are mostly composed of loose stones, rendering ascent difficult.

The rocks which occur seem to be of sandstone, much worn by the rain, and of a roughness and sharpness most discomforting.

6. Pending the commencement of weather which would allow me to enter the Bolan with any chance of doing work, I commenced my triangles from the low hills at the entrance of the pass, and worked across the plain towards Jacobabad, and succeeded in accomplishing about 25 miles. I then, on the 15th of February, commenced my march to Quetta, but experienced, even then, much bad weather and delay in the upper portion of the pass, and I think that in future, survey work in the hills cannot be commenced to advantage before the 1st March.

7. The Bolan Pass, from its commencement near Dadur, about a mile beyond the village of Pir, until within 3 or 4 miles of Kirta, is merely the rocky bed of the Bolan River, which is crossed quite a dozen times "*en route.*" Towards the entrance, the valley is wide, but after passing Kohan-Dilani, the first halting-place, the pass for about 4 miles is very contracted, and the sides high and precipitous. About 4 miles south from Kirta, the road enters a barren stony plain of some extent, which continues more or less for 17 miles, as far as a place called Tungee. There is some scanty brushwood and some attempts at cultivation near Kirta, which is a wretched little village. The distance from Dadur to Kirta by the pass is 27 miles, whilst the direct distance is only 14 miles, the pass making a long and acute bend around the southern portion of the Kirta range. Near Bibinani, the third halting-place, about half-way between Kirta and Tungee, is the entrance to the Rodbar Pass. Beyond Tungee, the hills close in again, and although the higher ones are at some distance, yet the lower hills come down to the bed of the river, and give the pass more the appearance of a defile. From Tungee to Mutch and Siri Bolan, the incline upwards becomes much more marked: the river here has no regular bed, but flows everywhere under

the small pebbles, showing here and there in small streams for short distances. The sides of the pass consist of an elevated stony plateau of gravel hills, cut by numerous deep and precipitous ravines. At the Siri Bolan, the Bolan River issues from numerous fissures in the rock: between Mutch and this, the western side of the pass, is the high hill called Coolic, which slopes up directly from the river bed. On the opposite side there are stony plateaux and numerous ravines between the pass and the two high and conspicuous hills of Shug and Nogdwar; these are capped with snow during a good part of the year. Beyond Siri Bolan the slope of the pass is still great, and it narrows very much, the last 5 miles being between high perpendicular rocks, which could be scaled only with difficulty in a few places; the south side is formed by a mountain called Mahomed Ghuzi. About 3 miles from Siri Bolan, on the north side of the pass, there is the Doozan Nullah, about a mile up which there is a good camping ground and plenty of firewood and water, the only place where it is procurable between Siri Bolan and Darwaza. About 1½ miles beyond the Doozan Nullah, the Sanghani Nullah branches off to the right; up this nullah there is a shorter path to Darwaza and the Dusht plain, which is practicable on foot and for led horses. The pass may be said to end about 12 miles from Siri Bolan, the road then emerging into a narrow stony valley, with low hills on each side, over one of the lowest of which—locally called the Kharlaki Kotal—the road is finally carried through a small cutting, and at once comes out on the plain called the lesser Dusht-i-bedaulat; this is nearly quite level with a clay soil and is covered with low scrub.

8. I append to this a rough sketch of the pass, compiled from the observations I was able to make, combined with the field-books of the telegraph line and the Superintendent of Telegraphs, Mr. Pitman, who probably knows more of the pass than any other person. Two high hills, Deak to the south, Zin to the north, nearly close in this lesser Dusht, there being only a small passage left, which is called Darwaza, and is the next stage after Mutch. A small tank has been constructed here, and a good well is in course of construction, and I believe it is in contemplation to erect some kind of "Serai" to protect the men and camels of the kafilas, to whom the snow-storms and bitter wind, which often sweep over this exposed plain, are frequently fatal.

On the lesser Dusht there are two wells and a dhuni, or summer village of Alladina Khoord, an influential Sirdar, to whom most of the Bolan belongs. These are situated some way to the south of the road under the hill of Deak. The greater Dusht extends from Darwaza westwards, as far as the hills called Kumbilan, about 10 miles, and south about 10 miles towards Mustung; to the north it branches into two valleys, the western and larger of which is the Quetta Valley, which extends northwards some 20 miles; it is narrowest (about 4 miles), a little south of Quetta, and is bounded on the west by the lofty hill of Chiltan and its continuation called Kurrughzuh, and on the east by a high range, with many peaks, generally called the Mardar range from its highest point. The valley is stony to the south, but fertile around Quetta; its general slope is from south to north; it is crossed by numerous lines of wells termed Korázás, wherever a stream descends from the hills: the Korázás are the work of professional well-sinkers from Candahar. The stream, instead of being allowed to work out its own surface channel, is lead through an underground tunnel, and at about every 50 feet, a well is sunk, from which water can be obtained for irrigation.

The valley is bare, the only trees being groves of apricot trees around the villages, of which there are many. North of Quetta the valley widens, and about 8 miles north it is closed in by the Tukatu range of an average height of 3,000 feet above the plain, rising on the north-east into two high peaks: to the north-weast is the Pishin Valley and road to Candahar, the north-east and east are two passes into the Dumar Pathan country, the northern of which begins near a small hill called Sira Kula; it is said to be an easy and practicable route to Dehra Ghazi Khan.

Extract from the Narrative Report, dated 1st November 1878, of CAPTAIN A. W. BAIRD, R. E., *in charge Tidal and Leveling Operations.*

I have taken up the reduction, by Harmonic Analysis, of the observations taken at Apollo Bunder for the whole of 1876 and January 1877. The reductions of these observations are the first that have been done in India, and necessarily the more intricate part of the work has had to be done by myself single-handed, and I have had to watch the computors carefully in every stage as the work progressed. In order to compare the values of the Short Period Components at Bombay, Okha, and Kurrachee, I have tabulated them side by side as follows.

Table showing comparison of the amplitudes and epochs of all the Short Period Tides for Bombay, Kurrachee, and Okha.

Table of the Co-efficients of the Short Period Tides for Bombay, Kurrachee, and Okha Tidal Stations.

STARS.	1876-77. BOMBAY. Latitude, 18° 59′ N. Longitude, 72° 50′ E.	1868-69, 1869-70, and 1870-71. KURRACHEE. Latitude, 24° 47′ N. Longitude, 67° 1′ E.	1874. OKHA. Latitude, 22° 28′ N. Longitude, 69° 7′ E.
	Feet. °	Feet. °	Feet. °
The Star S. ...	R_1=0·1077, ϵ_1=195·84	R_1=0·0727, ϵ_1=175·45	R_1=0·0741, ϵ_1=149·89
	R_2=1·6064, ϵ_2= 3·47	R_2=0·9326, ϵ_2=323·36	R_2=1·2224, ϵ_2= 14·37
	R_4=0·0230, ϵ_4=210·57	R_4=0·0141, ϵ_4=355·95	R_4=0·0132, ϵ_4=116·57
	R_6=0·0060, ϵ_6=172·40	Wanting.	R_6=0·0030, ϵ_6= 20·92
	R_8=0·0030, ϵ_8=266·18	Ditto.	R_8=0·0006, ϵ_8=219·81
The Star M. ...	R_1=0·1108, ϵ_1= 57·09	R_1=0·0345, ϵ_1=300·39	R_1=0·1122, ϵ_1=120·86
	R_2=3·9280, ϵ_2=330·7	R_2=2·5183, ϵ_2=296·55	R_2=3·6936, ϵ_2=348·08
	R_3=0·0702, ϵ_3= 29·04	R_3=0·0438, ϵ_3=332·24	R_3=0·0289, ϵ_3= 22·10
	R_4=0·1064, ϵ_4=324·28	R_4=0·0232, ϵ_4= 36·38	R_4=0·1265, ϵ_4=108·83
	R_6=0·0102, ϵ_6=232·56	R_6=0·0461, ϵ_6=221·87	R_6=0·0056, ϵ_6=272·57
	R_8=0·0022, ϵ_8=228·47	Wanting.	R_8=0·0102, ϵ_8=100·06
The Star K. ...	R_1=1·5427, ϵ_1=134·59	R_1=1·1939, ϵ_1=144·82	R_1=1·5605, ϵ_1=146·60
	R_2=0·5650, ϵ_2=355·41	R_2=0·2404, ϵ_2=333·92	R_2=0·4207, ϵ_2= 24·82
The Star O. ...	R_1=0·7845, ϵ_1=318·82	R_1=0·5919, ϵ_1=308·59	R_1=0·8095, ϵ_1=322·67
The Star P ...	R_1=0·4202, ϵ_1=315·44	R_1=0·3783, ϵ_1=317·20	R_1=0·3844, ϵ_1=319·94
The Star J ...	R_1=0·1399, ϵ_1=136·92	R_1=0·0640, ϵ_1=161·94	R_1=0·1231, ϵ_1=176·32
The Star Q ...	R_1=0·1691, ϵ_1=339·27	R_1=0·1188, ϵ_1=313·87	R_1=0·1596, ϵ_1=324·68
The Star L ...	R_2=0·1951, ϵ_2=141·65	R_2=0·0664, ϵ_2=126·35	R_2=0·1511, ϵ_2=224·77
The Star N ...	R_2=0·9522, ϵ_2=313·33	R_2=0·5991, ϵ_2=281·50	R_2=0·7551, ϵ_2=322·94
The Star λ ...	R_2=0·0291, ϵ_2=351·93	R_2=0·0475, ϵ_2= 92·91	R_2=0·0712, ϵ_2=204·40
The Star ν ...	R_2=0·0380, ϵ_2=345·65	R_2=0·1200, ϵ_2=275·08	R_2=0·1592, ϵ_2= 8·50
The Star μ ...	R_2=0·2073, ϵ_2=316·16	R_2=0·0583, ϵ_2=267·41	R_2=0·1896, ϵ_2=184·26
The Star MS ...	R_4=0·1203, ϵ_4= 40·50	R_4=0·0240, ϵ_4=241·55	R_4=0·0619, ϵ_4=112·37
The Star 2 SM ...	R_2=0·0494, ϵ_2=112·37	Wanting.	R_2=0·0434, ϵ_2=291·24

The proportion between the two chief tides (the solar and lunar semi-diurnal) at Bombay is about 1 to 2·4. It approaches nearer to the theoretical proportion (1 to 2·1) than at Kurrachee, which is 1 to 2·7, or at Okha, which is about 1 to 3.

Remarks on the Bombay co-efficient.

The solar diurnal (R_1 of S), which is larger at Kurrachee and Okha in proportion to the semi-diurnal component than is usually found, is in Bombay still larger.

The quarter-diurnal tide (R_4) of series S is larger than at Okha or Kurrachee, but the other over-tides (R_6 and R_8) are hardly appreciable, which is to be expected, as Bombay harbour is situated so close to the open coast.

The diurnal tides (K, O, P, J, and Q) are not found to be quite so large as in the Gulf of Cutch; but the proportion of P to O is as near the theoretical value 1 to 2 as was found to be the case in the Gulf of Cutch reductions. The values of the amplitudes and epochs for all the diurnal tides at Bombay and Okha are very nearly alike, while at Kurrachee the amplitude in each case is smaller.

Mr. Roberts had computed approximate co-efficients for a few of the main *quasi*-tides for Bombay, from four months' observations previous to 1872, and in the British Association Report he gives them "as the most probable values which are likely to be true for Bombay from the data available." I find that, as a rule, the amplitudes do not differ very greatly from those now deduced, but the epochs are in each case entirely different. This shows that it is very unlikely that anything like correct values of the epochs can be determined under a whole year's observations.

Co-efficients formerly determined by Mr. Roberts for Bombay from four months observations give the epoch entirely wrong.

A table is given on the following page showing the comparative values of the analyzed and equilibrium theoretical semi-diurnal tides, referred to the mean lunar semi-diurnal tide as unity, for Bombay, Kurrachee, and Okha. The epochs of all these tides are expressed in hour angles of mean solar time, and are referred to the meridian of the place. The values of the amplitudes of the *quasi*-tide L, which at Kurrachee agrees almost exactly with the equilibrium theoretical value, is half as much again at Okha, and nearly double at Bombay; and this is peculiar, for the other semi-diurnal lunar elliptic tide N, which is about seven times greater than L by theory, agrees fairly well at all three places with the equilibrium theoretical value. The smaller evection semi-diurnal tide (λ) at Bombay is exactly the same as the theoretical, but at Kurrachee and Okha it is three times too great; while for the larger evection semi-diurnal (γ) the agreement with the theoretical is close at Okha and Kurrachee, and at Bombay it is only one-fourth its proper magnitude. The variation semi-diurnal (α) is $2\frac{1}{2}$ times the equilibrium theoretical value at Bombay and Okha, while at Kurrachee it is practically the same as the theoretical. The mean solar semi-diurnal agrees more closely to its proper value at Bombay than at the other two places. No comparison has been made for the R and T *quasi*-tides as for Bombay and Okha; they have not been evaluated, two years' observations in succession being required to determine their amplitudes and epochs. The lupi-solar declination semi-diurnal K is slightly in excess of the theoretical value in Bombay, while at Okha it is slightly, and Kurrachee much less, than the theoretical value.

Comparative values of the analyzed and equilibrium theoretical semi-diurnal tides.

The complete separation of the mean lunar and mean solar semi-diurnal tides (M and S), together with their respective epochs, furnishes a ready means of finding the time of spring tides, or the time at which the two tides are exactly the same in phase. For instance, the mean solar semi-diurnal tide at Bombay attains its maximum when twice the mean sun's hour angle from the meridian is 3°·47. Similarly, the mean lunar semi-diurnal attains its maximum where twice the mean moon's hour angle = 330°·07. Dividing the difference between these two epochs by twice the difference between their respective daily motions, we obtain an interval which represents the time at which the two tides are coincident after the two bodies were in conjunction. The difference between the two daily motions is 12°·191.

The time at which the main semi-diurnal tides (M and S) are in the same phase, which corresponds to the average time of highest spring H. W. for Okha, Bombay, and Kurrachee.

The result for Bombay	= 1·372 days	= 1 day and 9 hours nearly.
„ Okha	= 1·099 „	= 1 „ „ 2 „ „
„ Kurrachee	= 1·078 „	= 1 „ „ 2 „ „

That is, the highest tide occurs at Kurrachee and Okha on an average about 26 hours after conjunction of sun and moon, while at Bombay it is 33 hours after.

Table showing the Comparative Values of the Analyzed and Equilibrium Theoretical Values of the Semi-diurnal Tides at Bombay, Kurrachee, and Okha.

	Mean Lunar Semi-diurnal.	Lunar Elliptic Semi-diurnal.		Evection Semi-diurnal.		Variation Semi-diurnal.	Mean Solar Semi-diurnal.	Solar Elliptic Semi-diurnal.		Lunı-Solar Declinational Semi-diurnal.
	M.	ν	*N.*	λ	γ.	μ	*S.*	*R.*	*T.*	*K.*
Periods	12·4206 hours.	12·1916	12·6584	12·2218	12·6260	12·8718	12·0000	11·9836	12·0165	11·9672
	R. = 1·000 unit.	0·027	0·192	0·007	0·037	0·022	0·476	0·004	0·028	0·127
Equilibrium theoretical values (Moon to Sun = 2·1 to 1)	Time of maximum = 0·00	0·00	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
Bombay.										
Latitude, 18° 55′ N.	R. = 1·000	0·050	0·242	0·007	0·010	0·053	0·409	...	...	0·144
Longitude, 72° 50′ E.	Time of maximum = 11·39	4·80	11·02	11·95	12·12	11·30	0·12	...	...	11·81
Kurrachee.										
Latitude, 24° 9′ N.	R. = 1·000	0·026	0·238	0·019	0·048	0·023	0·371	0·014	0·044	0·095
Longitude, 67° 1′ E.	Time of maximum = 10·23	4·28	9·90	3·15	9·646	9·56	10·78	6·39	1·30	11·10
Okha.										
atitude, 22° 28′ N.	R. = 1·000	0·041	0·204	0·019	0·043	0·051	0·331	...	...	0·114
Longitude, 69° 7′ E.	Time of maximum = 12·01	7·61	11·36	6·94	0·30	6·59	0·48	...	...	0·83

Investigation of the long period tides.

The mean height of the tide for each solar day, that is, the mean of the 24-hourly heights as originally observed, were first taken: these means were then cleared of all undue lunar influence on account of the incommensurability of the lunar tides with the solar 24 hours. This was carried out for the M, N, and O tides, which are generally found to be the only ones which have any sensible effect. The method followed in making these corrections is fully explained in page 371 of the British Association Tidal Committee Report for 1872. The mean heights, minus the sum of the corrections, gave the purified means for each day, and the mean of these 365 values gave the purified mean of the year. This quantity was then subtracted from each of the purified daily means, and 365 small differences termed ah. were then found. The process of the further reduction of the long period components from these value of Δh. is explained in page 372 of the British Association Report above quoted. The final values obtained for the long period tides at Bombay were as follows:—

Solar annual (elliptic) tide	...	$R=0{\cdot}079$ ft., $\epsilon=317°{\cdot}49$.
Solar semi-annual (declinational) tide	...	$R=0{\cdot}163$,, $\epsilon=195°{\cdot}89$.
Lunar monthly (elliptic) tide	...	$R=0{\cdot}027$,, $\epsilon=100°{\cdot}24$.
Lunar fortnightly (declinational) tide	...	$R=0{\cdot}071$,, $\epsilon=7°{\cdot}51$.
Luni-solar fortnightly (shallow-water) tide	...	$R=0{\cdot}032$,, $\epsilon=168°{\cdot}55$.

In order to compare the values obtained for Bombay with those deduced from the Kurrachee, Okha, and Hanstal (Gulf of Cutch) observations, I have drawn out a table on the opposite page giving the values of the amplitudes and epochs side by side.

In the solar annual tide the amplitudes for Bombay appears to be one-half the value obtained for Okha and Kurrachee, but about three times as great as that obtained for Hanstal; its epoch at Bombay agrees more closely with that at Okha than with any of the others: in fact it is a closer approximation to the Okha value than the two values at Kurrachee, *viz.*, for 1868, 1869 and 1870-71, are to each other. By taking a mean value of the epochs at Kurrachee I find it to be about 77°. Thus the time of maximum of the solar annual tide (the epoch of this tide being reckoned from the vernal equinox) would be about the 6th of February at Bombay, the 24th of March at Okha, and the 6th of June at Kurrachee.

		Bombay, 1876.	Okha, 1874-75.	Hanstal, 1874-75.	Kurrachee.		
					1868-69.	1869-70.	1870-71.
Solar annual (elliptic) tide speed (η) ...	R.	0·079	0·162	0·024	0·115	0·179	0·162.
	ϵ.	317°·49	3°·11	195°·32	43°·96	80°·20	107°·11
Solar semi-annual (declinational), tide speed (2η)	R.	0·163	0·121	0·090	0·198	0·059	0·062
	ϵ.	195°·89	144°·75	156°·38	81°·98	116°·93	69°·69
Lunar monthly (elliptic) tide speed ($\sigma - \omega$)...	R.	0·027	0·058	0·107	0·076	0·043	0·032
	ϵ.	100°·24	311°·38	14°·17	247°·73	175°·27	115°·90
Lunar fortnightly (declinational) tide speed (2σ)	R.	0·071	0·070	0·142	0·038	0·064	0·065
	ϵ.	7°·51	52°·73	45°·74	335°·40	333°·91	283°·22
Lunisolar syndic fortnightly (shallow-water) tide speed ($\sigma - \eta$)	R.	0·032	0·136	0·163	0·009	0·0075	0·058
	ϵ.	168°·55	249°·19	11°·76	326°·19	16°·98	156°·62

The solar semi-annual tide would appear to have a larger amplitude at Bombay than at any of the other places; by taking the mean of the values of two latter years as the value for Kurrachee, the amplitude at Okha is about double, and the value at Bombay nearly three times that at Kurrachee; but, although the epoch of this tide for Bombay, Okha, and Hanstal are not very divergent, the epoch at Kurrachee is totally different. For Bombay the times when this tide is at a maximum would appear to be about the 29th of June and 28th December.

The lunar monthly tide is about one-half as great at Bombay as at Okha or Kurrachee, and about one-quarter the value of the Hanstal tide. The epochs are very different between the different stations, but not more so than those of Kurrachee *inter se*.

The lunar fortnightly tide agrees well as regards amplitude (at Bombay and Okha), but at Hanstal it is twice as great; while at Kurrachee it is little more than one half what it is at Bombay: the epochs are tolerably concordant, two of Kurrachee values agreeing well together. The epoch of this tide is reckoned from the time that the moon's mean longitude is equal to 0 and 180°. The maximum would be attained at Bombay about 1 day 21 hours after it had reached its maximum at Kurrachee, while for the 2 stations in the Gulf of Cutch it would not reach its maximum for 3 days and 10 hours after Bombay.

The luni-solar synodic tide at Bombay is less than at any of the other places noted in the table, and is about half the value of that at Kurrachee, and one quarter that of the stations on the Gulf of Cutch. The epochs in every case are very divergent; for this tide the time from which the epoch is reckoned is the mean of the times of new and full moon.

Extract from the Narrative Report of CAPTAIN CHARLES STRAHAN, R.E., *in charge, No. 1 Gwalior and Central India Topographical Survey, for season 1877-78.*

Country triangulated.

8. The portion of country visited by Lieutenant Hobday in the course of his triangulation lay to the south and south-west of Oodeypore, and included both the small cantonments of Kherwara and Kotra, where the Bheel Corps is stationed. Most of the country belonged to Meywar, only small portions of Edar and Dungarpur being met with in the south-west and south. It embraces the widest portion of the Aravallis, which are here about 60 miles across. A short distance south of the parallel of 24° they may be said to cease, as the character of the country entirely changes, becoming far more open, with isolated hills of boulder formation, instead of the narrow parallel ridges of the true Aravallis. Although the summits of the ranges are considerably lower than those to the north, there is not so very much difference in the relative heights of the hills above the valleys, in consequence of the great fall in the country generally. This difference in level is best shewn by giving a few heights deduced trigonometrically. Gogunda, which is about 16 miles (as the crow flies) north-west of Oodeypore, and is situated on the watershed of India, is 2,750 feet above the sea, probably the highest town in this range. From this, following a line to the south-east, we come to Oodeypore, which is 1,957 feet (level of the bund of the tank). Continuing this direction we reach the Dhebar Lake, which is only 960 feet, and again beyond this to the Som River, which is only 650 feet above sea-level; the total distance is about 65 miles, giving a slope of about 32 feet per mile. Again, going due south to the cantonments of Kherwara, which are as nearly as possible 1,000 feet above sea-level, we obtain an average fall of 33 feet per mile in 53 miles. To the south-west, through Kotra cantonments, 1,033 feet, to Ker Bangalow in Edar on a branch of the Sabarmati, 694 feet, we find the slope to be over 35 feet per mile. To the west and north-west the slope is even more abrupt, as Dinapore, a small village near Pindwara in Sirohee, is only 33 miles distant, and is 1,525 feet below Gogunda, shewing a slope of 46 feet per mile, and to Behra in Godwar is a fall of 1,635 feet in 28 miles, or more than 58 feet per mile. As might be expected, the highest peaks of the Aravallis (not including Abu, which I believe does not properly belong to the range) are to be found in the neighbourhood of Gogunda; the highest of all is the culminating point of the Jargo Range, about 15 miles north of that place. The drainage of the south-eastern part flows into the Som, and thus into the Mahi; whereas to the west and north-west it flows into the Sabarmati. The rugged and impassable nature of this range of mountains has already been described in previous reports; but from Lieutenant Hobday's description to me, I am inclined to think that portions that he met with to the north-west of Kherwara will present more difficulties to the detail surveyors than any we have as yet dealt with. Entrenched, as you may say, within this wild bit of country is the Sagwara Pal, which bears quite as bad a character as the Nathario or Gangia-ka-Pals. This Pal is supposed to be under the Rao of Madre, but his power over it is but nominal, as he dare not enter it; and when he has occasion to go into Kherwara, he has to make a detour of some 15 miles to avoid passing through what is supposed to be part of his own territory. Lieutenant Hobday found it necessary to enter this Pal in the course of his work, and accordingly did so, although strongly against the advice of all the surrounding inhabitants. He had from experience discovered that the Bheels, if treated well, shewed at all events no active hostility towards Europeans, and he trusted to this, and was not disappointed. It was difficult to induce a man to guide him into the place, but, once in, everything went smoothly. He of course had no occasion to stay there; but the detail surveyor, who visits it, may meet with greater obstacles to his work; I trust, however, with a little tact, it will be surveyed without any *contretemps*. Captain Conolly of the Bheel Corps is the only other European who has penetrated this Pal; and he also met with no opposition. The comparatively good behaviour of the Bheels towards Europeans may be almost entirely attributed to the influence of the officers of the Bheel Corps at Kherwara and Kotra. Before these corps were organised, these wild tribes believed, and rightly too, that every man's hand was against them, and they could not understand that any one could possibly wish to visit their Pals, unless with a hostile intention. They trusted no man, and looked upon all intruders as enemies, or, at any rate, as fair prey for robbery. One of the Officers informed me that when the regiment was first started, they had to pay the sepoys daily, or otherwise they deserted in numbers, simply because they could not believe that, if they remained, they would receive their pay at the end of the month. Now that they have learned that honour and justice can really be found amongst Englishmen, there are nearly always a number of young men waiting for vacancies to be enlisted in the regiment. Desertion is still frequent; but this may be attributed to their great love of home and to the difficulty of drilling the necessity of discipline into their minds. As a proof of their love of home, I was told that it was by no means uncommon for a sepoy to walk some 15 or 20 miles to his home after his day's work, and be back in time for parade in the morning. The head-quarters of the corps are at Kherwara, a small station on the road from Oodeypore to Ahmedabad, about 50 or 55 miles from the former place. At Kotra is a detachment only under the command of one officer. All mer-

chandise passing up or down this road is escorted by Bheels, to whom a certain amount is paid as black-mail; a neglect of this precaution is almost certain to lead to robbery. Our camps, however, were never molested either here or elsewhere.

The country triangulated by Mr. Cornelius, and which I will now describe from notes furnished me by him, lay to the north, and, not including the outlying points he visited, was situated between the meridians of 73° 0′ and 73° 30′ and the parallels of latitude of 24° 30′ to 25°. Gogunda, which I have already mentioned as being probably the highest town in the Aravallis, is just to the east of where he commenced work. About 20 or 25 miles west of Gogunda he found himself on the edge of the plateau of Rajputana; from the summits of the ranges here, the drop down into the desert country was very marked, and although the country was still hilly to the west, the hills were more or less isolated, with large jungle-covered stretches of flat country between. Beyond this again could be seen a vast plain with only a few rocky hills here and there. The descent into the plains is not sudden and well defined as in the ghât formation, but much broken up by long spurs running down from the high ranges, forming, as it were, huge buttresses, to what may be called the retaining wall of the plateau. This portion will, I am afraid, present great difficulties to the detail surveyor; although well wooded, there appears to be very little water on these western slopes, and consequently camping grounds will be few and far between, and the plane-tablers will have their labour seriously increased by having to walk considerable distances to and from their work. When once past this belt, we shall get into easier ground, as, although still covered with jungle, the ground is flat without any very great amount of detail, and the peaks of all the higher hills around will generally be visible. To the south and south-west he was entirely within the Aravallis, the ranges as usual being long and parallel to each other, running nearly north and south, or north-north-east and south-south-west. The draining here is all southerly, and embraces the principal sources of the Sabarmati. The great drop in the country I have mentioned above forms the western boundary of Meywar, but it seems to be of the vaguest possible description; in many places indeed there appears to be no attempt at a fixed boundary. The lower country belongs to Jodhpore, or Sirohee, as the case may be, and the higher country to Meywar, but between them is a large belt of mountainous country belonging to neither, or perhaps claimed by both; disputes are of course very common, and both Lieutenant Hobday in the south and Mr. Cornelius in the north met political officers attempting to adjust some of the more serious disputes. This part of Meywar is principally the property of jagirdars, the chief of them being the Raos of Gogunda, Oghna and Jaura, of whom the first ranks amongst the 1st class nobles, and the two latter amongst the 2nd class. The low country to the west belongs partly to Jodhpore and partly to Sirohee; although between the hills the country is quite flat, it is very little cultivated, on account of the great scarcity of water; the cultivated portion lies in a belt of 1 or 2 miles in width, along the banks of the two dry river-beds; the one is the Joai which flows to the north-west, past Erinpura and eventually into the Luni: and the other is the Chota Banas, which flows south-west. Both rise in the western slopes of the Aravallis. The inhabitants of the hilly tract around the sources of the Sabarmati are almost all of the Garassia tribe, half Rajputs and half Bheels; they live in Pals like the Bheels, and resemble them in many ways, but are decidedly a superior race in all respects; the Rajputs will not recognise them as true Rajputs, but still they allow them to be far above the Bheels, as they take them into their household service, and even drink from the same vessel, which they would never do with Bheels. The origin of this tribe and the meaning of its name "Garassia" appears to be somewhat obscure. Mr. Cornelius obtained the following tradition from some of the better educated natives, which is said to account for their existence. During the time when the power of the Emperors of Delhi was rapidly becoming paramount in India, the armies of one of these Emperors overran Rajputana, subjugating the Rajput Chiefs. Two brothers, Kanerdejie and Ranoojie, of the Fort of Jalor, however, successfully opposed the imperial armies for a considerable period, until the elder brother fell a victim to the treachery of one of his own followers, who was evidently bribed to commit the deed, when the younger, despairing of being able to maintain a successful resistance, fled to the Magras (the local name of the hilly tracts), where he and his Rajput followers were heartily received by the Bheels, who shortly after begged Ranoojie to become their Chief and to permit his followers to intermarry among them. These proposals were at first respectfully declined, but eventually, when the imperial power was established in Rajputana, the Thakur and his men, making a virtue of necessity, settled down and took to themselves wives of the Ujla tribe of Bheels; such marriages were termed "garisthe" which means literally "a married man," but which in time acquired the signification of "brought into one family." It is probable that the descendants of these unions were known by this title which has been corrupted into "Garassia." The Garassias, unlike the Bheels, will not eat cattle or nilgai; they are far more civilised in manners, and usually in dress, than the Bheels and Minas; their principal weapon is the bow and arrow. Their houses are built in a peculiar style, the distinguishing feature being that they nearly all have plinths and verandahs; the roofs are made of branches of bamboo or korwa, closely matted together and plastered thickly with mud, over which are laid broad, coarsely made tiles; these houses, especially those of the higher classes, have a much neater appearance than the wide bamboo huts of the Bheels.

Remarks on the country plane-tabled.

9. The country plane-tabled comprised Standard Sheets 83, 84 and part of 87, between latitudes 24° 15′ and 25° 0′, and between longitudes 73° 30′ and 74° 0′, embracing a portion of the State of Oodeypore. The eastern parts of the first 2 maps were open and nearly flat, and fairly

well cultivated; the remainder, with the exception of the large valley in which the town of Oodeypore is situated, was one mass of hills and intricate detail. The Jargó Range, the highest of the Aravallis, fell in Standard Sheet 83; the culminating point of this is 4,315 feet above sea-level. To the west of this, in latitude 25° 7′, rises the Banas river, which for the first 15 miles flows south-south-west, parallel to the Jargo Range; it then turns abruptly to the east, rounding the southern end of the range; its bed here increases rapidly, but owing to the failure of the rains, there was but little water in it. After another 5 or 6 miles it reaches the Math Bál Range which it passes through in a fine gorge; from here it has less hilly country to pass through, but it does not reach the really open country for another 20 miles. When it once emerges into that country it becomes nothing but a sandy bed, all the water disappearing.

The Banas river.

A very notable feature in the Aravallis is the number of artificial lakes, some of them most picturesquely situated; the principal ones are the Dhebar, or Jai Samand, the Rae Samand, the Uday Sagar, and the Pichholia at Oodeypore. They are named in order according to their size. The Dhebar, which is perhaps the largest artificial lake in the world, is nearly 9 miles long by upwards of 5 miles wide, and covers an area of nearly 21 square miles, of which 0·8 square mile consists of islands. The area drained into it is 690 square miles. Its greatest depth was 78 feet, which was just before entering the range of hills which from the south-west edge of the lake to the dam I found to be 62 feet. The Rae Samand is in the country surveyed by No. 7 party, but I visited it on the march down and have also calculated its area, &c., from their maps. Its length is 3 miles, width 1¼ miles, area 2·9 square miles, and area drained into it is 194 square miles. The Uday Sagar is nearly 2½ miles long by 1½ wide; its area is 2 square miles, and it drains 179 square miles of country. The Pichholia is 2½ by 1¼ miles; its area 1·2 square miles and drains 56 square miles. The stream which has been dammed up to form this lake originally joined that flowing into the Uday Sagar; two other small lakes the Basi and Derali, between them draining 15 square miles, also stop some of the drainage into the Uday Sagar, which otherwise would be the second largest lake. Thus, these four lakes alone hold in their basins the drainage of 1,127 square miles of country. The water is utilised somewhat for irrigation, but not to any large extent.

Lakes.

Mr. Doran reports that he found old silver mines near Zower. Mr. Vanderputt states that there is copper at Dilwara, and Abdul Guffer says there are numerous old copper mines in the Keonra Nal. Iron ore was found in many places.

Ores.

10. The following are the principal places met with: Oodeypore, the capital of Meywar (commonly but erroneously known to Europeans as the State of Oodeypore); Bedla, Gogunda and Dilwara, the residences of three Raos; Náthdwára, a great Brahmin city and place of pilgrimage; Eklingji, a well-known shrine or a very old and well-known village close to Oodeypore, and the burying place of all the Máharanas of Meywar; Jargo, a temple at the foot of the range of the same name, where a yearly fair is held; and Zowar, a famous old city, now in complete ruin.

Towns and cities.

Bedla is only remarkable for being the residence of the chief Rao of Meywar; it merely consists of a fair-sized village surrounding the Rao's palace. It is situated 2 or 3 miles north of Oodeypore. The Rao is an elderly man, well informed, and most civil and friendly to Europeans; he behaved exceedingly well in the mutiny, for which service the Government presented him with a sword of honour. Gogunda I have already mentioned; it is a large town, considering its situation in the centre of the Aravallis, with a good bazar. The country immediately round the town is open and undulating, well watered, and would make an excellent site for a cantonment, as it is 2,750 feet above sea-level.

Dilwára is also a large town, picturesquely situated amongst the eastern ranges of the Aravallis. The palace of the Rao is on a conical hill to the south of the city, which it overlooks; about 2½ miles south is the hill temple of Dilwára on a remarkable conical peak about 1,000 feet above the city; the ascent is by a zig-zag road cut out in the rock on its west and south-west faces; the latter part is roughly paved. This hill forms a most prominent landmark for miles to the north and east. Náthdwára is a large walled city on the right bank of the Banas river; on the north, east and south it is surrounded by hills, but to the west, across the river, which here takes a very sharp bend, it is fairly open. It has the reputation of being an enormously wealthy city, which I have no doubt is true, as it is a great place of pilgrimage; every pilgrim giving what he can as an offering at the shrine of Srináth. Amongst the more valuable presents given to the Brahmins, are elephants and cattle; large herds of the latter graze on the hills to the east of the city, where there is a regular cattle farm surrounded by a high wall and guarded by sepoys; the cows in milk receive a daily ration of grain, all sorts mixed, which is boiled in an immense iron caldron. About two years ago the Mohunt or head Gosain of Nathdwára, became very troublesome, ignoring all orders of the Durbar, and otherwise misconducted himself to such an extent, that it was found necessary to send a force against him. It was supposed that he would resist, but on seeing some guns commanding his city, he gave in; he was banished to Muttra, and his son allowed to take his place, but at the same time some 300 sepoys, under the orders of a Kámdar, appointed

by the Durbar, were stationed there to ensure his good behaviour. Even now it is a place rather to be avoided, as the Brahmins are a very independent set, and apt to be insolent on very small provocation. All fishing and shooting is strictly prohibited within the ground belonging to this city.

Eklingji is but little more than a collection of temples beautifully situated on the bund of a tank and surrounded by hills. Approaching it from the north, you pass through a gateway built across the mouth of a gorge in the hills; a wall crowning the heights on either side. The road follows this gorge for about half a mile, the hills on either side rising perpendicularly up to a height of about 100 feet above the road, when you reach the back of the temples. From here you cannot see the lake, and I passed on through the little town inhabited by the Brahmins, ignorant of its existence. From the town the road ascends a short distance, up a steep, paved road, when you pass out at the south gate and find yourself on the bund of the upper lake, which is probably some 100 or 150 feet above the lower one. Originally, no doubt, there was a waterfall, or something very like it, below the upper lake, and the water from this stream joined the water which now forms the lower lake; the two together flowing out by the gorge which forms the northern entrance. The overflow of the upper lake is through an artificial channel to the west, which cuts through a very low watershed, and causes a small stream of water to flow down an adjoining valley. This stream puzzled me considerably for some time when I was working on it, as I could not at all account for it by the formation of the hills around. Eklingji is about 13 miles north of Oodeypore; the first 7 miles of the road are metalled, but at the 8th mile there is an abrupt ascent between hills where the road is roughly paved, steep enough to make it rather awkward riding up or down, and of course impracticable for wheeled vehicles: the descent on the other side is much less, and there the road winds along the foot of a hill forming one side of a pretty cultivated valley up to the banks of the upper lake. The Maharana constantly visits the shrine at Eklingji, of which he is himself the chief priest.

Ar is said to have been the origin of Oodeypore. In the present village, and all round it, are several temples, some of which are very richly carved. To the east of the village and enclosed by a wall are the Chhatris, built to the memory of the Maharanas of Oodeypore, and to their wives who committed satti here; they are all crowded together as close as possible, and no two are alike: beautiful green trees have grown up amongst them, and through the midst flows a little stream of water.

Jargo is a temple situated at the foot of the eastern slope of the range which takes its name from it. I have already mentioned this range as being the highest of the Aravallis. A large fair is held here annually.

Zowar is about 18 miles (as the crow flies) due south of Oodeypore. It is said to have been built as a place of safety for the Maharanis of Oodeypore during the wars with the Mohammedans. It is now little more than a mass of ruins, but there are still some interesting temples in and around what was the city: the walls of a large fort on one of the neighbouring hills are still to be traced. A small stream meanders past the west of the town; on the banks of this is a very fine *bauli* which looked to me quite new; a little up the stream are the remains of a large masonry dam, which must have held up a considerable body of water, but which is now completely breached by the stream. In this neighbourhood silver has been found, but the quantity is said not to be sufficient to make it pay. I believe Professor Bushel tried to work the mines as a speculation, but failed. It is evident, however, that in olden days a great deal of smelting was carried on here (some say for gold, but I believe that is a mistake), as many of the walls of the old houses are built entirely of old crucibles, giving them a most curious appearance.

Passes.

Though passes from east to west were few in number—one certainly, from Oodeypore to Gogunda, and thence through Semba1 to Erinpura or Sirohee—is worthy of notice, but I have not as yet got full materials for a description of it. On the completion of all the detail survey of this part of the Aravallis, I propose to notice all the passes met with; until then it is hardly possible to give much information.

Roads.

The only metalled roads met with were from Neemuch to Oodeypore, and again from Oodeypore *viâ* Kherwara to Ahmedabad. Full information as to the former is given in the route from Goona to Oodeypore *viâ* Jhalrapatan and Neemuch, which is now complete, and sent in as one route. The other road will also be treated in the same way when we have all the necessary information. It will suffice to notice now that it is on the whole a very good road, but very hilly. With the exception of the Som river, all streams are bridged. Any other through routes will be sent in on the regular form.

Rivers.

In the detail survey the only river of importance met with is the Banas river already mentioned; the Berach, which rises in reality from the hills north of Oodeypore, but which is known as the Ar until it flows into the Uday Sagar; for some miles after this it is known as the Uday Sagar river, and it is not until it has flowed some distance into the open country that it is universally recognised as the Berach. An almost equally large branch of this stream flows from Dilwára and joins it near Untálá. The Berach is a tributary of the Banas

All the other small streams flow into the Dhebar Lake or form part of the sources of the Sabarmati.

Notes on the Fort of Chittor.

Volumes might be written on the history of Chittor and its ruins; indeed the history would be almost that of the Rajputs. No attempt will be made to even briefly allude to this subject, but I propose to make a few remarks as to its size, position, and value as a fortress. Any one wishing for information as to the numerous ruins in and around the fort, and its general history, is referred to Todd's "Rajasthán." Chitorgarh is situated on a long, narrow hill, remarkably straight and even in its contour, lying almost exactly north and south. The extreme length from wall to wall is 5,735 yards, or 3 miles 2 furlongs 15 yards; its greatest width, which occurs at rather less than one-third of its length from the north, is 836 yards, or a little less than half a mile: this does not include the second lower wall, which is here found on each face, a little below the upper main wall. These would add another 40 yards, making it exactly half a mile in width. Towards the south the walls, following the shape of the hill, gradually taper to quite a fine point; the whole of the eastern face is very straight, without any re-entering or salient angles whatever; the western face has four indentations (they can hardly be called re-entering angles, as they are wide and open); two in the northern and two close together, quite at the southern half; between these two latter is the salient angle, with the exception of the southern extremity itself, to be found in the whole contour of the walls. The total length of the ramparts is 12,113 yards, or 6 miles 7 furlongs 13 yards. The nature of the hill itself is solid rock, gradually sloping upwards from the plain, and more or less precipitous throughout the whole extent at the top: in many places the precipitous portion is double, the lower precipice being also crowned by a wall. The stratification is nearly horizontal, but the dip is from east and west towards the centre; this is more particularly marked in the southern half of the fort; this formation has been taken advantage of in forming tanks, of which there are five large ones in this part of the fort, formed by merely throwing a masonry dam across in suitable places from east to west. At the foot of the hill on the west, about one-third down from the north, is the city of Chittor, which is approximately rectangular in form and is defended by a wall. This wall connects with the fort walls on the south side of the town, but ends at the foot of the hill on the north. The area of the fort is 693 acres 3 roods, and of the city 77 acres 3 roods 30 poles. To the west of the fort flows the River Gambheri, a branch of the Berach river. As it approaches from the south, its course is about north-north-west; and it passes within 735 yards of the southern extremity. It gradually turns a little northwards, till it comes abreast of the city, where it turns to the north-east, in which course it continues till it has arrived north of the fort, when it takes a sharp bend to the north-west for a very short distance, and then gradually curving back to the north-east, joins the Berach. Abreast of the city its distance from the city walls is 680 yards, and from the fort walls 1,410 yards: its nearest approach to the northern extremity is 615 yards, and its junction with the Berach, due north of the fort, is at a distance of 1,900 yards. Across this river at the bend, abreast of the city, is a very solid masonry bridge, which is in perfectly good order, but without parapets. The approaches to this bridge are steep, and, as well as the road-way over it, are paved with blocks of stone. This pavement is moreover slippery and not in the best of order; so the bridge is only used by foot passengers, all carts and beasts of burden preferring the ford immediately below the bridge to the north. The bottom is shingly, and the water about knee-deep.

At the extreme southern end of the fort is a small round hill known as Chitoria, connected with the main hill by a saddle-back; it is nearly flat at the top, but has an irregular-shaped mound running north and south, nearly in the centre; the distance between the edge of this hill and the southern bastion of the fort is 150 yards, but the fort wall is 150 feet above it. To the south and west there are no hills near the fort, the country being nearly a dead level. To the north-west, beyond the Berach river, at a distance of 2,200 yards, are a few low hills, forming a small range running, roughly speaking, north-east, parallel to the river. To the east, at a distance of 1,500 yards, is a very low rocky ridge running parallel to the fort hill; it is so slight an eminence that, from above, it is quite lost sight of. In length it is somewhat less than the fort, dying completely away towards the south. Beyond this again, at a distance of just 2 miles, is a higher range also running north and south. The top of this range may be said in a general way to be 160 feet lower than the fort walls and 300 feet above the plains. The length of this hill is rather more than 1 mile.

Almost due east of the southern point of the fort hill, at a distance of 2¾ miles, is the commencement of again another and higher range, which extends southwards for about 3 miles; this range is higher than the fort hill by about 50 or 60 feet.

To the east again we find a mass of high hills, formed by numerous parallel ranges, all running north and south; they are at an average distance of 3½ to 3¾ miles. The highest point is 2,001 feet above the sea, or about 200 feet higher than the fort. The general level of the country is a little more than 1,300 feet above the sea; the height of the banks of the River Gambheri, below the southern end of the fort, is 1,326 feet, and its junction with the Berach river is 1,300 feet, giving a fall from north to south of about 5 feet per mile. The height of the extreme north end of the fort wall is 1,761 feet, of the extreme southern point 1,819 feet; the eastern face is generally somewhat higher than the western, the highest part of the wall of the former being 1,825 (close to the northern extremity), the lowest 1,745, which is about midway. On the western face the highest point is 1,811; in the southern half of the fort, the lowest 1,697, which is at the main gate. The highest of the centre of the city is 1,331 feet. There are three gateways to the fort, the principal one being from the city on the east. It commences from the south-east corner of the city, and ascends the hill gradually in a northerly

direction, in nearly a straight line, for about 1,080 yards, passing under two gateways; the road then zig-zags, and passing under the third gate continues to the south for a distance of 235 yards, when it passes through the fourth gate; it again resumes its former direction passing the fifth gate, and after another 280 yards arrives at the main gate of the fortress, known as the Ram Pol. The total length of the ascent is 1,595 yards, and the slope, which is nearly uniform throughout, is about 1 in 15; the whole roadway is roughly paved. At the extreme northern point is the Lakola gateway, but it is only a small one, and the ascent to it is by a small rugged path; this is but little used. On the eastern face is the third entrance to the fort; the ascent commences from the village of Suraj Pol, by a rough road much cut up by the cattle passing up and down from the fort. The latter half of the ascent is by a paved road similar to the Ram Pol, but at a steeper gradient; the length of this ascent is 750 yards, and its average gradient about 1 in 7 or 8. The paved portion is probably not more than 1 in 10. This gate is known as the Suraj Pol. There was formerly a small doorway in the south-western part of the fort, but this is now entirely closed. Of water inside the fort walls, there is an abundant supply from tanks and "*baulis*" of which there are no less than 32. There is a perpetual spring from the lower part of the precipice over the city, which appears to be beautiful drinking water. The soil inside the walls is very rocky, but notwithstanding this, a great portion of the northern half of the fort produces annual crops of "*jowar*": in the centre are a few wheat fields, where they can be irrigated from the tanks, but to the south it is quite uncultivated. Of pasturage very little is to be found inside the walls.

From the above description it will be seen that Chitorgarh possesses great advantages as a fortress; the hill itself averaging about 450 feet above the surrounding country, precipitous at the top, and the whole covered with dense "*dhao*" jungle, forms in itself no slight obstacle. There is no commanding position within the effective range even of modern artillery. The weak point is doubtless the southern end, as a lodgment could without difficulty be made on the Chitoria hill, completely under cover from the fortress; this little hill is, however, extremely steep. From the formation of the fort no great extent sees the top of Chitoria, and hence the fire would not be much concentrated; still the command of 150 feet would give the defenders a great advantage; the approach to the fort walls would be first from this small hill by a steep descent of about 90 feet to the neck, and then an equally steep ascent of 200 feet to the foot of the walls, which are here particularly high and strong; the salient angle terminates in a huge circular bastion. This once breached by batteries under cover of the river bank and eventually from the top of Chitoria, a successful assault might be made, as the attacking column would not be much exposed in the final ascent, and both artillery and rifle fire could be kept up on the walls by the supporting columns till the very last moment, when the escalading party reached the summit.

Extract from the Narrative Report of H. Horsf, Esq., *in charge, No. 2 Khandesh and Bombay Native States Topographical Survey, for season 1877-78.*

Triangulation completed, and remarks on the same.

7. The area triangulated during the season comprises 2,067 square miles, including 209 square miles of overlap into the work of the Guzerat Party, embracing a series of 10 first class triangles connecting the Khanpisura with the Singhi series along the parallel of 20°, and emanating from the three sides of the triangle, Ajfer, Walwari, Anakwari of the former series, and closing on the side Sáler to Dopari of the latter; also a network of 234 Secondary Triangles, completing Degree Sheet VIII and 1¼ Standard Sheet of Degree Sheet IX. Numerous intersected points have been laid down, as in case the ground is of too difficult a nature to be traversed; it must be plane-tabled in the ordinary way and the trijunction points of village boundaries fixed by the plane-tabler. Great care has been taken with the first class stations, and the results are very satisfactory.

Mr. Wilson reports as follows on a portion of the district of Khandesh in which his triangulation lay.

Introductory.

Starting from the side Walwari to Anakwari of the Khanpisura series, I was directed to run a series of primary triangles westward, closing on the side Sáler to Dopari, Great Trigonometrical stations. This area embraces a tract of country, the greater portion of which is Khandesh and portions of Nasik and Baroda, or approximately speaking, having the line of latitude 21° 45′ to the south, the Tapti river to the north, the line of longitude 75° 0′ to the east, and to the west the line of longitude 74° 0′. This stretch of country embraces portions of the taluk as Dhulia, Virdel, Nandurbar and Pimpalner.

Natural features.

Of this tract, three-fourths may be said to consist of hills and plateaux, the remaining quarter consists of well-cultivated country in the plains. The portions between longitude 74° and 75° and between latitude 20° 52′ and 21° 15′ may be said to be a mass of hills. In this respect the natural aspect of Khandesh becomes quite altered to what it is in the east, where, from a rich low-lying country of black soil, it varies to an undulating, rugged, stony soil, intersected by streams rising from the Western Ghâts, flowing eastward, and then north to the Tapti river. The ground rises considerably from a height of about 700 feet near Bhosawal to a height about 1,000 feet above sea-level near the Ghâts.

Rivers.

The Pánjhra river rising from the mountain height of Saler, flowing by the large village of Warsa through the Pimpalner Pergunnah, then on still eastward through the Dhulia Taluk sweeping by the town of Dhulia itself, turns northward and flows on through the low country and plains into the Tapti river. The Kan river flows into the Pánjhra; it is a dry stream during the summer months, but of considerable width. The Pan river rising from the height of Bhamergar flows into the Tapti as well, having the Bori river as its feeder. The Amrawati river flowing by the village of Dhondaicha is another broad dry stream during the summer months; it flows as well into the Tapti river. The Patelgunga, which flows west of Nundurbar, and thence into the Tapti, is a running stream for half the year. The Suki, the Nisu, and the Surpai, which last flows by the village of Visarwari, all flow into the Tapti river. Of these streams the Pánjhra is the only river of note, flowing all through the year. There are several bunds in this river, which were constructed about a hundred years ago, and are to be found in the vicinity of the village of Pimpalner; these have been improved lately by Government, hence the extensive sugarcane plantations and well-watered fields of wheat that are to be seen on both banks of the river.

Inhabitants.

The inhabitants of Khandesh about Dhulia are for the most part Bheels, Brahmins, Mahomedans, Kunbis, and Chamars. The Bheels figure considerably in Dhulia itself on account of the Bheel Corps located there. At Pimpalner, which is about 45 miles west of Dhulia, the Kokanese, or people of the Konkan, appear on the scene. Ten miles further, about the village of Warsha, and all along the Ghâts above and below, the Kokanese muster strongly; the Bheels are fewer, and the Kunbis still less. The character of the Bheels, Kunbis and Mahrathas are well known, and need not be here described. The Kokanese are a simple people who are not much encumbered with dress, owing to the hot climate in the Dangs. They grow rice plentifully, and bartering is their mode of buying and selling. In appearance they are very dark, and differ considerably from the Bheels. In fact, they approach the Koles of Chota Nagpore more than any other race in habits and proclivities of taste. The women adorn themselves with necklaces of white beads strung together in rows of twenty to thirty; being composed of the seeds of a species of grass, these necklaces are very light and cause no inconvenience in respect to their weight. Their language is peculiar, being a combination of the Mahratha language and Guzerati.

Soil.

The soil of Khandesh changes considerably; from a rich black soil in the open country it changes to one of gravel or *moorum* in the undulating and hilly portions. Irrigation is frequently resorted to by means of wells which dot the fields of Khandesh, though water is obtainable at great depths.

Produce.

The staple articles of food in Khandesh are—

Wheat flour	sold last	year	from 7 to 8	seers	per rupee.
Joari	„	„	„ 9 to 10	„	„
Bajri	„	„	„ 11	„	„
Gram	„	„	„ 6 to 7	„	„
Arhar dal		„	„ 8	„	„
Coarse rice	„	„	„ 6 to 7	„	„

Forest.

From an extensive, well-cultivated country, Khandesh assumes the appearance of a hilly one, clad with shrubs and trees. Forest reserves of teak, sissoo and anjan have been marked off on our maps, where they grow; beside these there are most commonly the "khair," "bair," "bel," and farther west, approaching the Ghâts, we have teak, ebony, asan, sâl, mowali and nim. In fact, Khandesh is so bare of trees that the Collector has issued orders to the effect that the roads should be planted with avenues of trees, and has encouraged the practice by giving rewards for, and by defraying the cost of, the same. He has even imported the seed of the babul in large quantities in order to have a good growth of the same.

Roads.

Starting from Dhulia, the capital of Khandesh, there is a high road going west to Surat, passing by the respectable villages of Ner, Sakri, Dhabivel, Visarwari and Nowapur, in Khandesh; this road, then passing through the Dangs, leads to Surat. It is bridged and macadamised below the Ghâts, and is one of the principal roads in Khandesh; the traffic on this road is not so great, now that the railways have been opened, but Banjaras and travellers may be seen passing in numbers every day. Another road meets this one a few miles beyond Kasara village, which leads to the town of Malegaon; it is passable for carts and camels.

Farther west there is another road over the Selbarighat, which is also passable for carts, and it leads to the railway station of Manmad. Going south of Dhulia there is another main road on which the Government mails are conveyed to the railway station of Chatisgaon. On all these roads tolls are levied. There are no other roads passable for carts or camels over the chain of hills that separate Nasik from Khandesh.

There is another route from Dhulia which goes north to the large village of Songir, and then turns north-west to Nandurbar *viâ* Dhondaicha. From Nandurbar there is a high road which meets the road between Dhulia and Surat, already described, at the village of Visarwari; this is also an important road for traffic. From Nandurbar there is a road leading south to Nizampur, which passes over the Ghâts, though here broken up into several easy

ascents near the village of Ashta, and so on the road leads to Nizampur, the head-quarters of the Mahilkari subordinate to Pimpalner. The road then goes south, leaving the Bhúmer hills to the west, and then descends a ghât above the valley of the Pánjhra river. This road leads on to Malegaón as before described.

Geology.

The strangely tilted peaks about the Western Ghâts, and the steep and deep defiles running into them, are very curious and imposing. The columnar structure of the rocks is peculiar, especially on the range that separates Nasik from Khandesh. The hilly portions of Khandesh are covered with a strata of dark basalt, and the presence of felspar, hornblende, and iron ore, is also indicated.

In the range that passes by the town of Nandurbar there is a striking peculiarity. It runs east and west for about 50 miles, and is composed of a series of serrated peaks and ridges, sometimes disappearing below the ground, sometimes breaking off into parallel ridges, yet maintaining its course and peculiarity.

Legend.

There are two peaks called Roulia and Joulia near the well-known hill of Bhamergar. The legend connected with them runs thus:—Roulia and Joulia were two brothers, by caste Guzerati kunbis, agriculturists. One day, while engaged out in the field, they spied a woman coming towards them; each of the brothers said that she was his wife, and so a dispute arose. When the woman approached, they found that she was their sister, upon which they were overwhelmed with shame, and preparing a fire in the field they jumped into it and were burnt to death. The sister, seeing this, jumped in after them. Thus, the two peaks sprung up in memory of the two brothers, and the ashes of the sister turned into a tree, which is no longer to be seen.

Remarks on the country plane-tabled.

26. The country plane-tabled included part of the Western Satpuras, embracing portions of Barwani, Mathwar, and the Akrani Pargunnah of the Khandesh district, and the valley of the Tapti River in Khandesh. The former is of a most difficult nature, consisting of lofty plateaux and peaks, the under-features of which are very minute. The greater portion of this tract is covered with more or less dense jungle, which necessitated the use of the chain in ground ill-adapted for it. Owing to the prolonged drought, water was so scarce that the plane-tablers concerned had to dig for it at almost every encampment, often without success, which prevented their marching often, and hence work was greatly retarded, as they had frequently to go out long distances, and to have water carried for their khalasies in copper chatties, which soon became heated and tended rather to increase than allay thirst.

The valleys and some of the plateaux, although fairly populated, are very poor, and the coarsest supplies are not procurable, except at the largest villages, where the quantity is very limited. The country is accessible to camels in the more open parts, provided they are lightly laden. The villages consist of numberless huts scattered over the ground under cultivation, and are so intermixed with those of adjoining villages, that half a dozen villages in a productive valley resemble a vast encampment, huts being substituted for tents. To shew all these takes not only much time, but is a severe trial to one's patience. In plane-table 22 there is a lofty plateau called Turanmal, the highest point of which is 3,791 feet above sea-level. From this plateau emanate enormously deep gorges in all directions, maintaining their depth for several miles, which necessitated great exertion, as there is hardly a spot where it would be safe to take a horse. The country to the north of this plateau and up to the Nerbudda is very wild, and affords refuge for outlaws and robbers. On the other hand, the valley of the Tapti is well cultivated, the villages are numerous, and the inhabitants well to do. Along the banks of the river there is a belt of ravines and broken ground, very deep and intricate, where the main tributaries join. During last season, owing to the failure of the monsoon, there was great scarcity of grain and pasture, but fortunately there was sufficient of the latter in the Satpuras, and the cattle were driven in there in herds for many months. There is a belt of country from 6 to 10 miles wide at the foot of the Satpuras on the Khándesh side, which has been converted into a first class forest reserve, the boundary of which has been laid down in the plane-tables. There are no engineering works except at Padalda in the Shahada Taluka, where the River Gomai is dammed up, and the lands of several villages are irrigated by a canal flowing from it.

Forts.

27. No forts fall within the season's operations, excepting some in ruins, of which Ramgarh, situated on the southern face of the Satpura range, in latitude 21° 46′ 23″, longitude 74° 43′ 24″, is the only one worth noticing. Mr Warde, in whose work it fell, states: "The fort and palace are in a very ruined state, but must have constituted a formidable stronghold in former days. The site can be approached from the north, only by a pathway leading up from the village of Morwani. To the south and west the hill is very steep; some portions of the palace still remain, in one compartment of which is a staircase leading down to a second compartment about 30 feet below. At the further end of this small room is a very deep well, which is supposed by the Bheels to be unfathomable; the water stands about 20 feet below the mouth of the well. In the courtyard is an ancient cannon about 4 feet long, of a very peculiar form and rough make, the breach being considerably smaller than the mouth. This cannon, together with a few leading idols lying about the courtyard, are looked upon with great veneration by the Bheels, who will not attempt to touch them for fear of punishment from the god who is said to preside there, but continually keep clearing the ground round about of weeds and grass."

28. No towns or cities come under survey, but the villages named in the margin may be classed as towns, and are of sufficient importance to merit notice. The first four are the head-quarters of Maulatdars, and contain about 1,000 houses each. The surroundings of Taloda are very pretty; splendid trees affording dense shade, and forming capital places for encampments. Sháháda and Taloda, on account of their proximity to the Satpuras, are unhealthy from August to November or December. At Sárangkhera a large fair is held annually, at which a large number of people congregate. Turkhera belongs to a jaghirdar in Holkar's employ, who also enjoys the revenues of several smaller villages. Thalner is an ancient place where there is a ruined fort situated on the right bank of the Tapti, and was the scene of bloodshed in the early part of this century, when the Maharattas held sway. The British General who advanced on it demanded the surrender of the fort and town, which the Killadar consented to evacuate; but some Arab retainers, 400 it is said, rushed upon the unsuspecting soldiers, as they were entering the gate, and cut down a number, together with two officers, *viz.*, Major Gordon and Captain McGregor, whose tombs are in the fort, bearing inscriptions, and kept in good repair. The fort was then stormed, and the Killadar hung up to a tree in front of the gate, though it is believed he was not aware that treachery had been premeditated. The tombs of the officers bear the following inscriptions:—

Towns and Cities.

Shirpur.	Virdel.
Sháháda.	Amalgaon.
Taloda.	Prakasa.
Sindkhera.	Sárangkhera.
Dhondaicha.	Thalner.
	Turkhera.

"Here lie entombed the remains of Major J. Gordon, of Her Majesty's Royal Scots, who fell on the assault and storming of this fort on the 27th February 1818."

"Here lie entombed the remains of Captain P. McGregor, of Her Majesty's Royal Scots, who fell on the assault and storming of this fort on the 27th February 1818."

There are also three old Mahomedan tombs or mausolea fast falling into decay, with passages from the Kuran in raised characters over the doorways. In Barwani, Páti is the only large village situated on the Goi river in the Satpuras, the head-quarters of a tehsildar and the principal village of a pergunnah which derives its name from its Silawád. Newari Pánsemal, and Melan, though not worthy of notice for their size, are yet places of some importance, as being situated in the jungles, and at which alone a few supplies are procurable.

29. The well-known and picturesque plateau of the mountain called Turanmál, with its beautiful lake at an elevation over 3,000 feet above sea-level, is situated in standard sheet 29. Turanmál derives its name from *turan*, a berry, and *mal*, signifying a plateau. The summit of the mountain, the highest point of which is 3,791 feet above sea-level, consists of a series of plateaux, the total area of which is about 10 square miles. It is presumed that the Government is already acquainted with the advantages which might be derived by having a sanatarium on this mountain: but it may be as well to state that I was encamped in a single fly *sholdari* on the bund or dam of the lake, under the shade of a small tree, affording very little shade, and did not feel the heat at all; in fact, at times it was so chilly, that I had to keep myself warm by walking up and down the bund, as I only took up light summer clothing with me. This was on the 13th April, when the thermometer stood at 107 degrees at the foot of the hills in a double fly tent under the shade of a large banian tree. The lake is half a mile long and quarter of a mile broad, very deep, and containing an inexhaustible supply of pure and delightfully cold water. Strange to say, there is not a fish in the lake, although shrimps are plentiful. One of the Collectors of Khandesh gave the place a trial for one season some years ago, and condemned it as being malarious: but when one comes to consider that he hutted himself only 40 feet above the water during the rainy season, it is not improbable that this fact accounts for his having found it unhealthy. If he had even resided on the lowest plateau above the lake, he would possibly not only have been better satisfied with the salubrity of the place, but escaped the innumerable musquitoes and insects which swarm round a light after dark. Grass is exceedingly plentiful; there is very little brushwood, except near the lake and in the gorges, and water could be conveyed to any part by mules, as the villagers, who have their habitations scattered all over, derive their water-supply from the lake alone; moreover, a plateau of about 4 square miles is below the level of the lake, to which water could be conveyed by pipes. The chief difficulty would be in getting up the mountain, as the distance from Báigor, which is at the foot of the Satpuras on the Sháháda side, to the summit of the mountain, is about 24 miles, Bákrata, a village in the Barwáni state, being half way; but last April arrangements were being made to open out a relief work for the benefit of the Bheels inhabiting the Páti pergunnah in Bárwani, by constructing a road from Báigor to Bakráta, by which half the difficulty will be overcome. There will then remain 12 miles, along which there would not be any serious obstructions, as the existing pathway between Bakráta and Turanmál is practicable for lightly laden camels. Jharar, which is half way up, and at an elevation of about 3,000 feet, could be converted into a half-way place, though it would be necessary to store water, as the spring is a very small one, and entirely fails in May.

Hills. Turanmál.

Another remarkable hill is deserving of notice, named Báwangaz, about 4 miles south-west of Barwáni, the capital of a Native State of the same name. On the highest point of this mountain, which is a peak, stands a temple, on the veranda roof of which is a Great Trigonometrical Survey principal station of the Khanpisura series, 2,111 feet above sea-level. This temple is dedicated to a god, about 200 yards below, hewn out of a rock in the scarp. The figure is 52 cubits high, whence it derives its name Báwangaz, or 52 yards, the yard measure of the district being 18 inches or 1 cubit. Masonry has been used in parts to give

Báwangaz.

the limbs their proper shape, but the greater part is cut out of the rock. There is a good road leading up to the temple from the foot of the hill, and half way up there is a *bauli* or well, where a fair is held annually. Báwangaz is a god of the Marwaris, a class of traders and money-lenders from Jodhpore, who have settled in almost every town of the Bombay Presidency.

Passes.

30. The Hindal-Bairi Pass, in latitude 21° 49′ 40″, and longitude 74° 36′ 30″, formed by the saddle connecting the mountains of Turanmál and Mandin, is situated on the road from Sháháda in Khandesh to Páti in the Satpuras, and is at an elevation of about 2,700 feet. It is not much frequented, except by Banjáras, but might easily be opened out and supersede the circuitous road adopted at present. Another, called the Boráli Pass, in latitude 21° 45′ 0″ and longitude 74° 57′ 20″, between Newáli on the south and Chiklia on the north, is a much easier one, and is practicable for carts. The main road from Sháháda to Rájpur passes over it. There are other difficult passes, but as only pathways run through them, notice has not been taken of them.

Roads.

31. The principal roads in the season's operations are the Agra and Bombay road, in standard sheet 33, which is kept in good repair, as the traffic on it is still heavy, chiefly in grain and cotton from Indore; another from Chopra to Taloda *viá* Thálner, Shirpur and Sháháda, a good country track, practicable for wheeled conveyances, and repaired occasionally; another, also a country cart track, from Amalner to Sháháda *viá* Betáwad, Sindkhera and Sárangkhera, where it crosses the Tapti over a hard sandy bottom; another, a Banjára track from Sháháda to Barwáni *viá* Páti, crossing the Sátpurá range through the Hindalbairi Pass; and lastly, from Sháháda to Rájpur *viá* Pánsemal and Newáli through the Boráli Pass. This is a good cart road, but over a difficult country, especially about 8 miles, *viz.*, from Moida Chauki to Newáli, where it runs along a ravine with hills on either side, and through dense jungle.

Rivers.

32. The Nerbudda, which comes into a corner of plane-table 56, flows over a narrow and rocky bed, with precipitous hills of considerable height, rising abruptly from the water's edge. This stream is not navigable throughout its course in degree sheets VII and VIII. The Tapti flows a little within the southern edge of the season's operations, and has a fall of 150 feet in 70 miles. Both banks are raviny, and the ravines at the junctions of the larger tributaries are very heavy. The large tributaries of the Tapti named in the margin have very little water in them during the dry season, excepting the Girna and Aner. The former enters from the south and brings down the drainage of a large tract of country above the Ghâts, and the latter receives the drainage of the Satpuras, within the limits of degree sheet V. Of the others, the Amráwati and Gomai take their rise in the Satpuras, and the Bori, Burai and Amráwati flow from the south, taking their rise a long way out of the season's operations. Besides these, the Goi river flows right through plane-table 54, and joins the Nerbudda in standard sheet 27; and the Jharkal takes its rise from Turanmál lake, and joins the Nerbudda in standard sheet 28, forming the boundary on the west between Khandesh and Barwáni. Five of the rivers mentioned, *viz.* the Aner, Arunáwati, Gomai, Goi and Jharkal are now completely surveyed from source to mouth.

Girna.		Arunáwati.
Aner.		Burai.
Bori.	Gomai.	Amráwati.

Inhabitants: their customs, &c.

33. The inhabitants of the revenue-paying portion of Khandesh are Mahrathas, and are so well known that any reference to them in a report like this would be out of place. Those inhabiting the Satpuras are exclusively Bheels and Bheelalás. The latter derive their origin from the Rajputs on the father's side, and from Bheels on the mother's. They are a peaceable, hard-working race, and are the principal cultivators in the Native States comprised within the limits of this survey, and think themselves greatly superior to their cousins, whom they look upon as pariahs. The Bheels are the same everywhere—a sly, thieving lot, with hardly any religion, and a set of vagabonds, deriving their livelihood from fruits, gums, and berries when in season; stealing when they have the opportunity, and starving rather than work. Their belief is in *deotas* or gods, and they imagine the spirits of the dead ride about on phantom horses. Their women are perfect slaves and are the workers, so that a Bheel with three or four wives is well off, as all of them take an active share in obtaining their lord's livelihood. No peculiarity in their manners or customs was noticed beyond what has been recorded in former reports.

Products, soil and cultivation.

33A. The products of the area plane-tabled are grain of various kinds, cotton and linseed; the soil in the plains being a black cotton, well adapted for the growth of cotton, which should, if properly cultivated, be greatly improved. On the hilly tracts every available spot in the Native States is cleared and brought under cultivation; the crops being chiefly *jowar* and *bajra*, and only here and there is wheat to be seen. In the British portion of the Satpuras, almost the whole is reserved as forest, and cultivation is rather discouraged than otherwise.

Extract from the Narrative Report of CAPTAIN J. R. WILMER, B. S. C., *in charge, No. 5 Topographical Party, Bhopal and Malwa Survey, for season 1877-78.*

Country plane-tabled.

The country plane-tabled lies between latitude $\frac{23°\ 0'}{23°\ 30'}$ and longitude $\frac{75°\ 30'}{77°\ 0'}$ belonging to the States of Gwalior, Indore, Bhopal and Dewás, and is well cultivated and open. But through the

centre of this portion, running north and south, are a series of low hills covered with brush-wood jungle. This range of hills commences in the Vindhya range, and runs north out of this survey into the ground allotted to No. 1 Survey Party. These hills are from 100 to 200 feet, and one very conspicuous peak stands 550 feet above the general level of the ground, 2½ miles west of the town of Shájáhánpur (or Shájápur as it is known there), and is 2,000 feet above sea-level.

Rivers.

The following are the rivers met with this season: "Parbati," "Newaj," "Káli-Sindh," "Lakhundar," "Chhoti Káli-Sindh," "Sipra," "Gambhir," and "Chambal." These rivers all take their rise in the north slope of the Vindhya range and flow almost due north. There are also many feeders to these rivers, and are only known by local names, the stream generally taking the name of the nearest village.

Country triangulated.

The country triangulated embraced an area of 1,865 square miles, of which 593·9 square miles were done by Lieutenant Gore and 1,271·1 by Mr. Atkinson. In Lieutenant Gore's portion a little difficulty was experienced in selecting stations, owing to the flatness and equal height of the hills.

Towns, products, &c.

The only towns of importance met were Ujjain and Sháhjápur (Sháhjáhánpur). A branch of the Indore State Railway goes to Ujjain, where there is a dâk bungalow. Mr. Wainright also reports that a branch telegraph office has been established here. A small portion of Scindiah's army is quartered here. Ujjain is built from the old material of ancient Ujjain and is now only partly surrounded by walls; it is entered by twelve gateways. The houses in the chief street are, many of them, four and five stories high. This city is remarkable for its old masonry sun-dial, built by a Hindu Rájá; a similar one to the one here is built at Benares; the Ujjain one, however, has been allowed to fall into decay. Ujjain is remarkably dirty; no sanitary arrangements being in force, and the population being so large as 34,000, and the area of the inhabited city being only 1¼ square miles, the filth can be better imagined than described. Mr. Wainright found it a hot-bed of cholera and fever.

Sháhjáhánpur is a large town on the Agra and Bombay road, has a post office, telegraph office, and staging bungalow. It has been proposed to carry a line of rail through the town *viâ* Tarána from Ujjain, thence to Sehore. The town is known everywhere by the name of Shájápur, but in the authorised spelling orders it has been entered as Sháhjáhánpur. The usual serials are grown almost everywhere, but the chief cultivation seems to be opium, which is extensively eaten by the wealthy.

Extract from Mr. D. Atkinson's *Memorandum*.

The area triangulated embraces portions of the States of Gwalior, Rutlam, Selana, Jaora, Dewás and Piplauda. The States of Jaora and Dewás are now completed; as portion of the former had been completed by No. 1 Topographical Party, Gwalior and Central India Survey, and portion of the latter had been finished during the previous seasons by this party. The Chambal and Maleni enter from the south about 16 miles from each other, separated by a spur of high ground, 12 miles in length; they flow parallel to one another in low, broad, well-inhabited valleys with very raviny banks, and in rocky beds. After the Chambal reaches the large and important village of Tal of Jaora State, where a detachment of the Central India Horse is located, it runs to the west amidst very raviny ground, and receives the Maleni, whence it flows north-east and enters the country already mapped. Along the west of the area triangulated the ground is hilly and very broken, having to its west the valley of the Siv, another tributary of the Chambal. West again of this tributary is the great watershed of India, dividing the Bay of Bengal river system from those flowing into the Arabian Sea; this watershed will come within the operations of a future season.

The metalled road from Indore to Neemuch passes through this area, and not far from it the earth-work for the railway is being rapidly thrown up. The Neemuch State line is under its first stage of construction. It is worth recording that the inhabitants have gladly taken to labour on its construction, as from all that could be ascertained by the Surveyor, the metalled road was made chiefly by Poorbeahs and labourers who had come from a distance, and later in the season the Surveyor saw none but foreign labourers on the new road leading from Ujjain to Agar. Thus this portion is fast undergoing great changes. Not many years ago it was a tract with the usual dry-weather cart tracks, with inhabitants averse to labour, save in their fields.

In this area are the following cities and large villages: Mandsaur, Sitamau, Marh, Kunda, Laduuia, Nagri Kachrod and Baldia of Gwalior; Jaora, Hatpiplia Bhairoda, Tal and Mandawab of Jaora; Ringnaud of Dewas and Piplauda of Piplauda.

Soon after I commenced work in this tract, water began to fail; and it was no common sight, later on, to see whole villages labouring at the deepening of wells to ensure water till the rains set in; and to witness, still later on, strings of villagers bearing water from a distance for their daily use to their villages, the usual wells and water sources having then failed altogether.

Extract from the Narrative Report of MAJOR W. F. BADGLEY, B. S. C., *in charge, No. 6 Topographical Party, Khasi and Garo Hills Survey, for season 1877-78.*

Remarks on country triangulated.

8. The triangulation in Sylhet would have been quite easy but for one or two things. There are three ranges of hills, the Pathariya, Dewallia and Chatachura, running parallel to each other and about 9 miles apart; between them the ground is spread out in broad flat valleys; between the first two the Langai valley, and west of the Chatachura range, the Chargola valley. The Chatachura and Dewallia ranges have smaller ridges at about a mile and a half parallel to them on their western sides, and the Pathariya on its eastern side. Laying out the triangulation was therefore very easy, but carrying it out was difficult. No coolies could be got without the help of the police and orders from the Magistrate, and those brought only came after every possible delay, and often ran away. No one would act as a guide, and the hill fixed on had to be found by sending climbers up trees and by experimental cuttings. There was no way of distinguishing one hill from another, as all were equally covered with forest, and they were so nearly uniform in height, and the trees on them so large, that often after clearing a point the view from the ground was found to be intercepted by the tree tops of smaller hills. There were no paths among the hills except one or two used for communication between the valleys on either side. The jungle in the hollows among the hills was very dense and often of that most obstructive of plants, cane, and in these places, which were besides usually swampy, the only way of getting about was by wading along the beds of the streams—a very slow, unpleasant, aguish business. The weather also was against the work. The Chatachura ridge, which at the peak at the south-easternmost corner of the district is 2,069 feet above the sea, and from thence slopes gradually down towards the north, and the two other smaller ridges I have named above, cause a good deal of rain to fall at intervals throughout the winter (it is the rainiest part of the district in the summer) and also prevent the dissipating of the night fogs, which from November to the beginning of March cover the country from sunset till noon next day, and are so thick that the drip from the forest sounds like heavy rain. In March these fogs began to clear away earlier in the day, but only to be followed by dust mists through which opaque figures are only visible at the shortest distances. The rain which begins in this month clears the air for a short time, but makes the country impassible, brings out the malaria and lurks other pests in the forest, so that work has to be closed with the month. Another difficulty in surveying the country is that of getting from one range to the other. There are large swamps (jheels) in both valleys, which make the distances double on account of detours; and after rain the paths (there are no roads) are slippery slush, and the streams which have no bridges are often unfordable for a day or two; altogether the country is disagreeable and unhealthy. The inhabitants are cowardly to a degree. I have seen thirty grown-up men, at sight of myself and two klassies with my guns, throw down their sickles, turbans, and whatever was easily got rid of in the way of clothes, and scamper away over their fields till they reached the jungle and hid themselves. They are liars for the pleasure of lying, and are of the sort who would mislead a blind man for the pleasure of seeing him fall into the ditch. They invariably misdirected me when I had occasion to ask the way, a thing I have never experienced anywhere else, and they are impudent when they think they can be so with safety, and dangerous also when the odds are not less than a hundred to one in their favour, having even more than once beset and beaten unfortunate solitary Englishmen. I found the trouble of collecting coolies for cutting the jungle so great, even near their villages, that I preferred, when I could, to do without them, and as a good part of what has to be surveyed next field season is uninhabited country, to which these people could not be taken, I am engaging Khasias for the work of clearing, which they do excellently well, as well as for carriage, which they are equally good at.

Extract from Report of LIEUTENANT-COLONEL G. C. DEPREE, S. C., *in charge, No. 7 Topographical Party, Rajputana Survey.*

MEMORANDUM ON THE USE OF THE WATER-LEVEL IN SURVEY OF HILLS AND HILL CANTONMENTS.

1. During the late field season, the party under my charge was mainly employed in the survey of the country on each side of the cart road from Simla to Chandi, south of Kalka, on the scale of 6 inches = 1 mile.

It would have been hopeless to have expected inexperienced Native Surveyors to survey the difficult mountains about Simla if only the ordinary system of eye-sketching had been employed, for this would require great skill. Hence it was determined to run a series of contour lines, at intervals of 250 feet vertical height (or four to every thousand feet) which should not only tie down the Native Surveyors, as it were, and confine their sketching to narrow strips only on each side of their contoured lines, but which would allow nearly true eye contours to be drawn intermediately to the levelled contour lines; thus the necessity of a Surveyor being an artistic draftsman would no longer remain, for the whole process would be almost reduced to a mere mechanical operation. Hence in the maps of the late season artistic drawing has not been

Diagram of a Water Level, resting on the top of a Plane Table tripod, to illustrate paragraph 2 of extract from COLONEL DEPREE'S report.

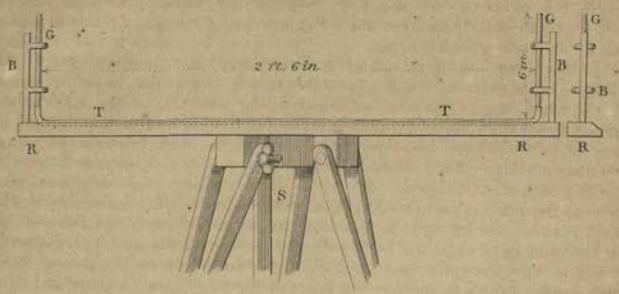
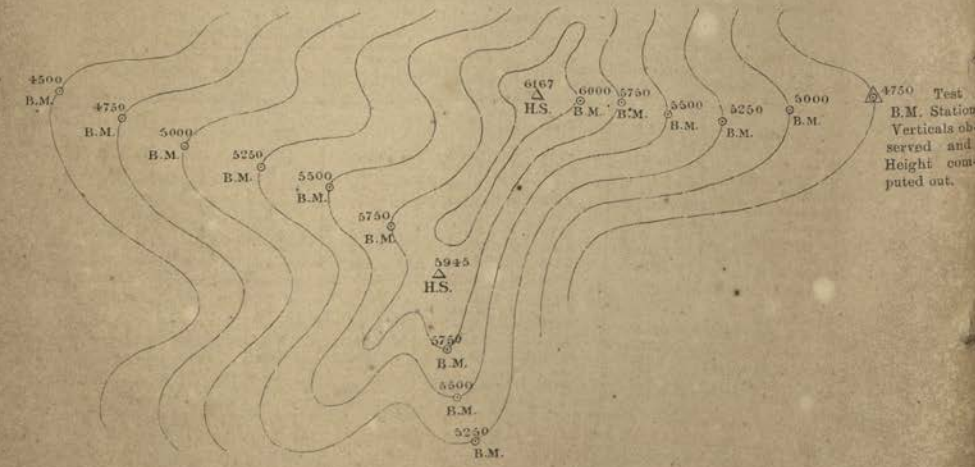


Diagram referred to in paragraph 4 of COLONEL DEPREE'S report.



sought for, but instead, well-contoured maps, a share of which even the inferior draftsmen have been able to contribute.

2. The common water-level newly adapted to the current requirements afforded an accurate and simple instrument for the purpose. It was made up, as shewn in the annexed diagram, by a bazar mistree, and cost Rs. 2-8 or Rs. 3. The idea of employing the water-level originated, it is believed, with Lieutenant E. P. Leach, R.E. The systematic use of it was, however, elaborated subsequently, and its make was slightly changed so as to secure less chance of breaking.

A rule RR of wood, 2¼ feet long, with bevelled edge, grooved to receive the India-rubber tubing TT; BB brass supports for glass tubes, GG glass tubes 6 inches long, fitted into ends of the India-rubber tubing.

TT India-rubber tubing ⅛" diameter fitting tight over ends of glass tubes, about 30 inches long. S, an ordinary tripod plane-table stand, which may be set up on any hill side, up or down, which a man can climb. The khalassies who carried the level rule always held it, when set up for work, loosely touching the top of the plane-table tripod, so as to allow of it revolving in any required direction. The palm of the man's hand acted as a sort of pivot, which became a clamp on the desired direction being obtained, by his fingers being pressed down on the top of the tripod. A long 17-feet levelling staff was used, so as to render necessary as few readings as possible in a given height. The ruler being aligned on the level staff, the observer brought his eye into line with the upper surfaces of the water in the glass tubes, and entered in his field book, the reading of the staff, facing that level. It was found that a very accurate reading could be obtained, notwithstanding the capillary irregularity existing, owing to the distance apart of the two edges, *viz.*, 2½ feet.

N. B.—If TT breaks, or splits with use, it can be mended by cutting out the defective part and joining the two ends by inserting a bit of glass tubing.

3. As usual, before taking the field, stations or points had been fixed trigonometrically on all the highest hill peaks. These were computed out and were projected by spherical co-ordinates on the Surveyor's plane-tables on the scale of 6 inches = 1 mile. The heights were also determined, and these formed the basis of the subsequently executed water-levels.

4. The process of levelling was as follows :—Bench marks were fixed by myself and a European assistant. The highest peak was chosen as a starting-point and the most commanding, and therefore most extensively visible, spur was chosen upon which to fix bench marks. If the height of the peak had been determined already, the Surveyor simply levelled down till he reached a height corresponding to a multiple of 250. Thus, if the hill was 6,167 feet high, he levelled down 167 feet, and there erected a pile of stones with a bamboo and flag, making permanently the 6,000 line. Then, in succession, he levelled down 250 feet further, and fixed the 5,750 feet bench mark, and so on successively he fixed the bench marks at every 250 feet. (*See diagram annexed.*)

5. Should the height of the highest peak not have been determined, the Surveyor set up his theodolite, observed vertical angles to two adjacent trigonometrical stations from these two sets of observations and the corresponding distances taken by measurement from the positions fixed on his plane-table, computed out the height on the spot, and proceeded as described in the foregoing paragraph.

6. On the close of the day's work, or on reaching the lowest bench mark in a valley, the leveller would set up his theodolite, observe vertical angles to two known heights, and fix his position again by plane-table, and compute on the true height of his position to form a comparison with his height as determined by water-levelling. The details of comparison given in the accompanying table are given at random :—

Comparison of water-level heights with trigonometrical heights.

Name of initial station.	Name of closing station or height of bench mark.	Trigonometrical.		Water-level height of closing station.	Difference or error of water-level.	Difference of height between upper and lower station.	Name of Surveyor.
		Height of initial station, see para. 5.	Height of closing station, see para. 6.				
From	To	From	To				
Bado ...	6,000	6,768	6,009	6,000	−9	768	Mr. J. H. Wilson.
No. 26 or Dudli ...	5,750	6,467	5,756	5,750	−6	711	
No. 70 T. F. ..	5,000	6,621	4,998	5,000	+2	1,623	
Cart road ...	No. 72 hill	4,858	6,357	6,350	−7	1,499	
Solon H. S. ...	Khanog H.S.	5,199	6,517	6,514	+3	1,318	
Debnu temple ...	Thani H. S.	5,195	6,170	6,175	+5	975	*N. B.*—Other test heights are available, but there is no leisure now to copy them. These are the first of the series.
Pachmunda ...	5,031	6,608	5,031	5,032	+1	1,577	
Madhu H. S. ...	4,750	5,426	4,754	4,750	−4	676	
Sanawar ..	4,764	5,804	4,764	4,760	−4	1,040	
	4,250	5,180	4,254	4,250	−4	926	
Koti Banian ...	3,000	3,772	3,005	3,000	−5	767	
Harli temple ...	3,319	4,817	3,310	3,319	+9	1,507	
Banasar H. S. ...	2,922	4,651	2,922	2,927	+5	1,729	
Sohog H. S. ...	2,650	3,701	2,650	2,646	−4	1,051	
H temple ...	2,750	4,817	2,753	2,750	3	2,067	
T garh ...	2,750	3,758	2,746	2,750	+4	908	

8. A simple field book was employed of four columns : (1) back reading ; (2) forward reading ; (3) difference ; and (4) remarks.

9. Two readings were always taken of the staff which was turned end for end between each. The level adjusts itself in an instant, and the double observation corrects errors of reading and errors of instrument, owing to possible air bubble in the India-rubber tube.

10. For the 6-inch survey, lines of bench marks were run down spurs at distances averaging one mile apart: at that distance the bench mark flags were conveniently visible; on the 24-inch survey, the distance was reduced to about half.

11. The bench marks having been erected on the ground* the detail Surveyor fixed the position of any convenient one of them on his plane-table by the usual method of interpolation, and proceeded thence along the contour line, if possible, setting up his plane-table, fixing his positions at convenient intervals on that line, and drawing in between these positions the line followed by the contour, as well as the detail to the right and left. To ensure his forward station being on the contour line, he would generally send a flagman ahead, and signal to him to move up or down, until, by the aid of the water-level, he found him to be on the true level. But this procedure was not actually necessary; it was just as accurate for the Surveyor to move on, taking his plane-table and water-level with him, and ensuring his position on the contour line, by shifting his position up or down hill, until he found by the help of his water-level that he was on the same level as the bench mark from which he started. The Surveyor could thus leave the contour line whenever he found it desirable to do so, and, after having done what he required off the line, could resume his position on it whenever he pleased.

12. Having completed the survey of the ground immediately above or below the contour line first taken up, the Surveyor would move to the next contour line, 250 feet above or below, and work as before, and so on, until the ground above each contour line had been surveyed. The levelling and surveying would thus proceed *pari passu*, eye contours being drawn in between the levelled contours to represent minor features of ground.

13. Some Surveyors preferred to survey the features of ground first, and then to insert the contour lines, but this involved going over the ground twice.

Extract from the Narrative Report of MAJOR H. R. THUILLIER, R.E., *in charge, Nos. 8 and 9 Topographical Parties, Mysore Survey, for season 1877-78.*

Remarks on the country.

8. In such a well-known province as Mysore, of which a copious Gazetteer exists, a minute description of the country seems unnecessary in a report of this nature, and it will suffice to make a few remarks on the nature of the ground which has been met with in the course of the last season's operations. I should preface these remarks by a general description of the province, which I cannot do better than by taking the following extract from the *Gazetteer of Mysore*, vol. I, pages 1 and 2:—

"The State of Mysore occupies a position, physically well defined, in the south of India, and has been termed a rocky triangle, a not inapt description. It is a table-land, situated in the angle where the Eastern and Western Ghât ranges converge into the group of the Nilgiri hills west, south, and east; therefore it is enclosed by chains of mountains, on whose shoulders the plateau which constitutes the country rests. On the west, the boundary approaches at one part to within 10 miles of the sea, but in general, preserves a distance of from 30 to 50 miles from the coast; on the east, the nearest point is not less than 120 miles. The southern extremity is 250 miles from Cape Comorin. The northern frontier is an exceedingly irregular line, ranging from 100 miles south of the River Krishna on the west, to 150 on the east.

"The general elevation rises from about 2,000 feet above sea-level along the northern and southern frontiers to about 3,000 feet along the central water parting, which separates the basin of the Krishna from that of the Cauvery, and divides the country into two nearly equal parts. But the surface is far from preserving the even character suggested by the designation of table-land; for the face of the country is everywhere undulating, much broken up by lines of rocky hills or lofty mountains, and scored in all parts by *nalas* or deep ravines. There is probably not a square mile in the superficies absolutely flat or level; the slope of the ground ranging from 10 to 20 feet per mile in the more level portions, and as high as 60 and 80 feet elsewhere.

"The country is longitudinally intersected by single or aggregated chains of hills running chiefly north and south, or in a direction nearly parallel to the two coasts. They lie at uncertain and unequal distances from each other, and accordingly form sometimes wide and sometimes narrow valleys. Isolated massy rocks, termed by Europeans droogs, rearing their heads to 4,000 or 5,000 feet above the level of the sea, stand forth like sentinels on every hand, mostly crowned with the remains of fortifications, whose position, with the advantage of an unfailing supply of water at the summit, rendered them well-nigh impregnable strongholds. Besides these, clusters of piles of hacked rocks, composed of immense rounded boulders, are frequent, large fragments being often delicately poised, like logging stones upon some projecting point, appearing as if a touch would overturn them, and yet sometimes supporting a shrine or mandapa."

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* Small piles of stones round the base of a red flag at every 1,000 or 500 feet level, or a white flag at every 750 of 250 feet level, the bamboos of which were 4½ feet long, or the same as the height of a plane-table when set up for work, so that the top of the table and the top of the flag being on the same level, their respective sites would also be on the same level.

It will thus be seen that, although the province of Mysore is popularly called a *table-land*, this appellation conveys a very inaccurate idea of the character of the country. One of the chief features for which Mysore is famous is the number of tanks it contains. These tanks run in "series," and are formed by embankments thrown across a valley at favourable points, the outflow from each tank supplying the one below it. They vary considerably in size, increasing towards the bottom of a series, where they often form large lakes. The low-lying lands are irrigated mainly by these tanks, which number above 37,000.

9. The portions of country triangulated in Degrees XI, XIV and XV, having been reconnoitred during 1875-76, and a short description given thereof in last year's report, it is only necessary to add that it is confined to the Mysore district, and that the country to the south in the Gundlupet and Heggaddevankote *Taluks* (sub-divisions) bordering the frontier, which runs along the foot of the Nilgiri hills, is extremely wild, covered with dense and unhealthy forest, where habitation is scanty and locomotion exceedingly difficult. The most conspicuous of the isolated hills in this part is that of Gopalsami-betta, 4,772 feet high. To the south-east, in Degree XV, are the Bilikalrangan (or Biligiriranga) hills running north and south, the principal range in the district, which rise to a height of 4,973 feet.

The country triangulated in Degree VIII lies almost entirely in the Tumkur district, where it is open and populous. The triangulation embraces a considerable range of hills running north and south through the eastern part of the district which forms the eastern boundary of the portion of country which drains into the Krishna river. It contains several bold fortified hills, well known for their historical associations during the time of Haider Ali and Tippu, *viz.*, Midageshidurga (3,414 feet); Maddagiridurga (3,933 feet); Channaraydurga (3,740 feet); and Siddabetta (4,197 feet). This range continues through the western portion of the Bangalore district to the valley of the Cauvery.

10. The country topographically surveyed was similar in all respects to that met with and described last year; some portions being of a gentle undulating character, interspersed with isolated groups of low rocky hills; in others, the undulations are bolder and more marked; while in some parts chains of hills were met with, varying in height from 3,000 to 4,000 feet above the sea, with the surrounding country much broken up by intricate ravines.

The principal hill surveyed is that of Devarâydurga, a few miles east of the town of Tumkur, resorted to by the European residents there as a sanitarium. Near the summit, which is 4,154 feet high, are two temples, the scene of an annual festival. The fortifications which were built some 250 years ago are carried round the hill in three separate lines, and must have been formidable in former times, but are now mostly in ruins.

Extract from the Narrative Report, dated 26th August 1878, of MAJOR T. T. CARTER, R.E., *Deputy Superintendent, 2nd grade, late in charge Guzerat Party.*

Remarks on the country triangulated (sheets 5 and 77) by Mr. Christie.

The whole of sheet No. 5 is foreign territory, three-fourths being Gaekwari, and one-fourth belonging to the Edar State under the Mahi Kánta Agency, the Sábarmati river being the boundary between the two; the western portion of this sheet is thickly wooded, consequently the country is unsuited for triangulation, and this portion has been traversed over. To the east of the Sábarmati the country is open and favourable for triangulation. Every field seems to have its own kutcha well, the mud excavated from which being impregnated with lime, has hardened into little hillocks, which form quite a feature of the country, and afford admirable points for both triangulators and plane-tablers. Sheet No. 77, with the exception of three or four villages belonging to the Mahi Kánta Agency, is entirely Gaekwari territory. The soil in this part is impregnated with salt, there is consequently very little vegetation, and the country being open, it has been covered with a net-work of triangulation, the stations being built for the most part on the banks of tanks, which are very numerous. The water in the wells being brackish, the inhabitants are dependent upon rain water for their drinking supply. From the western margin of sheet No. 77 to the Sábarmati river, the whole country presents one flat, unbroken surface, but east of that river, and at the north-east corner of sheet No. 5, there are out-cropping rocks rising from 30 to 100 feet high, worn into all kinds of fantastic shapes by the action of the weather, presenting a very curious appearance; and this is to be noticed on a much larger scale amongst the hills to the north of the sheet. Mr. Christie describes Chitror H. S., one of these out-cropping rocks, most difficult to ascend; what at a distance seemed a bare solid rock, really consisting of a number of immense blocks separated from each other by deep fissures.

Although the country in sheets Nos. 5 and 77 is entirely foreign, Mr. Christie met with no difficulty in carrying on his work, but he mentions that villagers and travellers are subject to constant attacks by bands of robbers, who lie in wait in the nalas, or come down in force, generally about harvest time, and carry off all they can lay hands on.

Sheet No. 24, of which the southern half has been triangulated, consists of part of the Edar State and several minor States or Talukdaries under the Mahi Kánta Political Agency. Along the western margin of this sheet, and for some 4 miles to the east of it, the country is open and slightly undulating; the remainder of the sheet is intersected with extensive ranges of hills gradually increasing in height towards the north, being spurs from the Aravali range of hills. These hills are covered with thick low jungle consisting of kurwye (*Hymenodiction abovatum*), rheyn (*Swietenia febrifuga*), timburni (*Diospyrus montana*), sag teak (*Tectona grandis*),

pallus (bastard teak), &c., necessitating a good deal of clearing in carrying on the triangulation.

Sheet No. 25 is comprised chiefly of British territory belonging to the Prantij Taluka of the Ahmedabad Collectorate, the remaining portion of talukdaris is under the Mahi Kánta Political Agency. The eastern portion of this sheet is hilly and suitable for triangulation; the western half slightly undulating; this portion of the sheet has been traversed.

The inhabitants of sheets Nos. 24 and 25 are chiefly Kolis and Bheels. Mr. Bond mentions that there is still one class of the latter who are professional robbers; they live in the hill jungles, and are called Garásias; probably they take their name from Garás, meaning "black mail" which used to be levied in former years by the Koli Chiefs. Mr. Bond was warned not to let his men go about singly, as, owing to the prevailing scarcity, these Garásias were committing more depredations than usual. In the hills, tigers and leopards were frequently met by our signallers, and the whole of the tract of country triangulated by Mr. Bond may well be described as wild.

Sheet No. 6 contains 143¼ square miles of British territory, 63 of the Mahi Kánta States and 341 of Gaekwari territory. The whole of this sheet is richly wooded, with the exception of the north-east corner, which is bare and covered with large salt marshes. The country is entirely flat, with the exception of the corner mentioned, where it is undulating, the hills in some cases rising to a height of 50 feet.

The River Sábarmati runs through this sheet, and its banks are reticulated by deep ravines varying in depth from 50 to 200 feet, and extending in many places to a distance of a mile from the bank of the river.

One of the most remarkable features of the country in this sheet is an extensive sheet of water in a hollow, close to the town of Prantij, called the Bokh, a description of which may be found in the Transactions of the Bombay Geographical Society, 1844-46. It is supposed to have been the original bed of the Háthmati river, from which the stream was diverted into its present course by Sultan Ahmed Shah, the founder of Ahmedabad, his object being to increase the quantity of water in the Sábarmati river, on the banks of which he had just founded his new city.

In sheet No. 7, the country is for the most part level, though to the east of the city of Ahmedabad there are a few small hills, as well as at the north-east corner of the sheet. On the banks of the Meswo and Wátrak rivers the ground is undulating and considerably cut up by deep ravines. In the vicinity of Ahmedabad the country is very much hedge-bound, and abounds with remains of Mahomedan tombs and musjids; the whole sheet is more or less covered with mango, tamarind, mhowa and rheyn trees. Near the village of Bahigel there are several remains of tombs, mosques, and idgas, shewing that at one time there was a large Mahomedan city in the neighbourhood, probably one of those said to have been built by Mahomed Begura about the year 1480 A. D. On the banks of the Wátrak are the ruins of an old fort which he is also said to have built; it is called by the people Ajamanath-na-kot. The present villages of Apruji, Radawat, Sarawat, and Chelawat occupy the site of what was at one time a large city called Para, to protect which, the fort above mentioned was built.

The country in sheet No. 27 differs considerably from that previously described, being of a much more sterile nature. Between the Rivers Luni and Shedi is one vast tract of land covered with scrub jungle. The soil of this part is what is called "Mal," an impoverished description of black soil requiring a great deal of draining and manuring to bring it under cultivation. To the east of the Shedi the country becomes more productive, the soil changing to a sandy nature. In the neighbourhood of the Mahi river and on its left bank extends a chain of low sand-hills from the southern margin of the sheet up to the village of Kuni. At the north-east corner we have the town of Balasinor, which is built on some low hills of trap rock some 350 feet above sea-level; while to the north-east of these hills rises an isolated hill of granite called Deodungri, 450 feet above sea-level. The hills about 2 miles north of Balasinor are covered with teak jungle.

The whole of this sheet is more or less covered with small drainage streams extremely difficult to trace, while the right bank of the Mahi river is reticulated with deep ravines. The country on the east bank of the Mahi is almost entirely covered with teak jungle.

Extract from the Narrative Report, dated 27th September 1878, of J. McGILL, Esq., *Officiating Assistant Superintendent 1st grade, in charge Kattywar Party.*

General features of country surveyed.

The country surveyed, except in the parts skirting the Gir forest, and the portion known as Barda, is flat and uninteresting in scenery. The sea margin from Porbandar to Mángrol is rocky, of limestone formation, and in many places almost presenting a honeycombed pavement of limestone, with low ridges running along the coast, covered with cactus bushes. The soil in a great measure is rich black earth, which produces good crops of cotton, jowari, bajri and sugarcane, and in some parts wheat, turmeric, &c. Owing to the scanty rainfall this season, however, no cotton was grown, and the bajri and other crops were meagre. Large tracts were sown with gram and *till*, but owing to blight, these crops also were very poor. During the months of February and March the cultivators, wherever possible, planted owari and carrots to enable them to feed their cattle during the hot months.

Industry of inhabitants.

The intelligence, industry, and patient toil of the people, which came under my notice during this season of scarcity, are very praiseworthy. In parts of the country in which water could not be obtained from wells, the cultivators erected "motes" (stages for leather water-bags) for raising water on the banks of streams, in the beds of which temporary wells were dug; from these as much ground as the water would run over was irrigated; and to enable the water to reach a higher level, other temporary wells were scooped out, into which the water was made to run; and over these other "motes" were again erected 10 to 12 feet high, and the water thus raised was used to irrigate ground which otherwise would have lain waste.

Gir Kanta.

The country skirting the Gir is undulating, and is covered with dense low jungle of khair, sisam, tembarwa, and thorny trees. The land here is fast being reclaimed from the Gir forest, and little villages are springing up with patches of cultivation round them; the fields dotted with fresh stumps of trees, fringed by the dark gloom of the forest, and the sharp stroke of the axe, tell of the steady march of civilisation in this jungly and malarious tract of "Gir" or forest, the haunt of the lion and panther.

Bardas.

The Barda hills came under survey this year; like those of Girnár, in Junágarh, they form a remarkable geographical feature of Kattywar. They are of fine granite, and one of the hill peaks, Vinu, rises to a height of 2,057 feet. They cover an area of about 70 square miles, and are very rocky, the sides of the hills being scattered with blocks of granite, and the peaks covered with huge blocks of rock 20 to 30 feet high. The jungle is low and composed of cactus, tembarwa, dudla, khair, and most plentifully with palas, or the bastard teak. The grand bar and pipal trees of the Gir are wanting here. The few bamboos that are found in the hills and villages are much prized for their strength and durability. The lion once frequented the Barda hills, but since the thinning of the jungle, he has left these haunts, and is now only to be found in the Gir forests. Panthers, however, are numerous, and sambar are still found in small numbers.

Remarkable ruins, &c.

To the north of the Barda hills lie the ruins of the once large town of Gumli, with its old and graceful temples and tanks, now falling to decay, the former residence of the Jetwa Rajput Chiefs, who, at one time, ruled over the half of Kattywar, their territory stretching from the Rann of Cutch to the southern coast. The lineal descendant of these Chiefs is now the Rana of Porbandar; but his territory has been reduced, by the inroads of the Jam of Nawánagar and the adjacent Chiefs, to a small strip of territory along the western coast known by the name of Barda.

Abapura Fort.

On one of the highest hills of the Barda range is the ruined fort of Abapura, 1,938 feet above the sea, which was at one time a place of great strength; and, from its possessing some tanks of good drinking-water, was, during the Wagher rebellion, occupied by a strong body of these marauders, who were with difficulty shelled out by a British force sent against them. The walls and towers of this hill fort have since been dismantled, and the reservoirs for water broken. At the foot of the hill is the famous old temple Kileshwar Mahadeo, embosomed in pipal and bar trees, a place of pilgrimage for devout Hindoos; and 2 miles south is the remarkably pretty tank called Sakroda Talao, near Koriar Nes, with its ancient temple, supposed to have been built centuries ago. It is from the spurs of the Barda hills to the south, about 3 miles from the pretty village of Adatiana, that the well-known white limestone is quarried, called in Bombay Porbandar stone.

District of survey.

The season's work lay chiefly in the districts of Barda, Hállár and Soruth, under the Political Assistants of Hállár and Soruth Prants. The Barda district is under the Chief of Porbandar, Hallar under the Jam of Nawánagar, and Soruth under the Nawab of Junágarh.

Towns.

The chief towns in these districts are Chhaya, Porbandar, Bhanwar, Rawal, Ranawao, Kandorna, Navibandar, Mangrol, Malia, Madhavpur, Sutrapara, Korinar and Adwana, Shil and Chorwar.

Chhaya.

Chhaya is a small town, at one time the residence of the Ranas of Porbandar. It lies about 1 mile south-east of the town of Porbandar and about half a mile from the shores of the Indian Ocean. Population 1,118, composed chiefly of Mhers and Kolis. Chhaya is a pergunnah of the Porbandar State, and has 9 villages subordinate to it.

Porbandar.

Porbandar is a large and flourishing sea-port town, the residence of His Highness the Rana of Porbandar, a descendant of the once powerful Jetwa Rajput Chiefs of Kattywar. It has a population of 14,500, and a number of wealthy merchants of the Bhatia and Bania castes. It has a very fine port for country craft, and affords safe anchorage for vessels of 80 tons burden in the creek which runs close under the walls of the town. It boasts of no municipality, and its sanitary arrangements are very bad, the streets filthy and very narrow. The town is surrounded on two sides by a creek which, not being bridged over, is a source of much inconvenience and trouble to carts and people visiting the place from the interior. Porbandar carries on a thriving trade with the Persian Gulf and Indian ports. Its chief exports are grain, ghee, and slabs of white limestone for building purposes. The ancient name of Porbandar was Sudámápuri, and as such it was considered a place of sanctity. With its rich green gardens

of cocoanut and almond trees as a foreground, and its white spired temples and the rugged high peaks of the Bardar to the back, Porbandar looks a very pretty and thriving town. The water-supply is plentiful, but it is brackish.

Bhanwar. Bhanwar is a small town lying about 2 miles to the north of the Barda hills at the junction of the small river Bhanwati with other streams. It has a population of 4,200, composed chiefly of Sindhis, Kunbis, Kolis, Lowanas, and Mhers. It is remarkable for its manufacture of native matchlocks and swords. It is a pergunnah town of the Nawánagur State, with 31 villages under it. Water-supply from river and wells plentiful.

Rawal. Rawal is a small town and a pergunnah of the Nawánagar State, with a population of 2,780. It is chiefly remarkable for its extensive rice-fields, which lie to the south-west of the town in the low ground inundated by the Wartu and Sani rivers during the freshes of the monsoon. The river here splits up into a number of small streams and channels before it merges into the Miani creek. Rawal has 10 villages subordinate to it. Water-supply plentiful from river and wells.

Ranawao. Ranawao, a small town belonging to the Rana of Porbandar, with a population of 2,870, chiefly Mhers and Kolis, who are all cultivators. The high road from Kuntiyána to Porbandar passes by this town, and a fine bridge is built over a mountain torrent which runs to the west of it. Ranawao is a pergunnah of the Porbandar State, with nine villages under it. Water-supply from wells plentiful.

Kandorna. Kandorna is a small walled town belonging to the Rana of Porbandar, with a population of 2,070, on the banks of the Minsar river, which here is a fine broad stream with rocky bed. The inhabitants are cultivators of the soil. This town is on the high road from Rajkot to Porbandar. Water-supply plentiful from river and wells. A fine bridge is about to be erected here over the Minsar.

Navibandar. Navibandar is a small sea-port town at the mouth of the Bhadar river, belonging to the Rana of Porbandar. It has a population of 1,347. Water from wells brackish, but plentiful. It is a small sea-port town, but has not a good harbour. It has eight villages subordinate to it, and a Waiwatdar and Fouzdar reside here.

Mángrol. Mángrol is a large town belonging to a Mahomedan Chief and relative of the Nawáb of Junágarh, and under the Nawab's jurisdiction. It has a population of 15,340 souls, and is a thriving sea-port town, with a small light-house on the sea-shore, and some high picturesque buildings, which, peeping out of the surrounding trees, give the town an Italian aspect. The B. I. S. N. Company's steamers touch here on their way from Karachi to Bombay, every week, for passengers. Mángrol has 22 villages under it, and carries on a small trade with the Persian Gulf and Malabar coast. The water-supply is plentiful from wells.

Malia. Malia is a small town, with a population of 2,500, lying on the western skirts of the Ghir forest; it has 36 villages under it. It is a fortified town on the banks of the Megal river, and is the residence of a Waiwatdar and Police Fouzdar. Water-supply from river and wells, good and plentiful.

Sutrapara. Sutrapara is a small town and pergunnah of the Junágarh State, with a population of 2,950, and 30 villages under it. It is a small sea-port town and carries on a coasting trade. Water obtained in abundance from wells.

Shil. Shil is a small town about 2½ miles from the sea-shore. It has a population of 1,180 souls, engaged chiefly in agriculture. It is a pergunnah of the Junágarh State, with 46 villages under it. Water-supply from wells.

Chorwar. Chorwar is a town and pergunnah of the Junágarh State, with 12 villages under it. It has a population of 2,800 souls, chiefly Kolis and Kumbhars engaged in agricultural pursuits. It is about 2 miles from the sea-coast.

Korinar. Korinar, a small walled town, with a sea-port belonging to the Gaekwar of Baroda, and a population of 5,900 souls, is situated on the bank of the Singaora river. During the Wagher rebellion this town was surprised by a band of these outlaws, carried by escalade and looted, and some of the garison killed. It was soon, however, evacuated on a force being sent against them from the cantonment of Dhari. Korinar is a pergunnah of the Baroda State, with 66 villages subordinate to it, and is the residence of a Kamdar and Fouzdar. A police force is quartered here.

Adwana. Adwana is a small walled town and pergunnah of the Porbandar State, with a population of 1,278, and has 23 villages under it. A Kamdar and Fouzdar remain here. Water-supply from wells.

Rivers. The principal rivers which run through the district are the Bhadar, the Ojat, and the Singaora.

Bhadar. The Bhadar river rises in the hills near Jasdan in the centre of the peninsula, and running a course of 120 miles south-west, falls into the Arabian Sea near Navibandar. It is the largest river

in the peninsula, with steep rocky banks, and is navigable for small boats up to Kuntiana, 20 miles from the sea; during the months of July, August, and September.

Ojat.

The Ojat is a small river which takes its rise in the low hills north of Manakwára, and, receiving all the drainage of the northern portion of the Gir hills, runs a course of 60 miles in a south-west direction and falls into the Bhadar river near its mouth at Navibandar.

Singaora.

The Singaora rises in the heart of the Gir forest, and runs due south a course of 40 miles, falling into the sea about 4 miles south of the town of Korinar.

Gorakhmadi Monastery.

The only places of interest in the district under review are the well-known monasteries of Gorakhmadi and Prachi Kund. The Abbot of the monastery is called Bawa, or Guru, said to have been Gorakhnath, the spiritual guide of Rakmabai, the Queen of Krishna. The Guru has 40 or 50 "chelas," or disciples, under him, who are all celibates, but the Bawa himself is exempted from the vow of celibacy to enable the Gadi to be perpetuated. If issue fails to the Bawa, one of his disciples, or "chelas," is selected for the post. The ears of all these Bawas are slit, and they are known by the name of Khanphati Bawas. Gorakhmadi has several villages assigned it for its support, and the Bawas being held in very great veneration by all Rajput Chiefs, the revenues of the monastery are large.

Prachi Kund.

The River Saraswati, which is considered sacred by Hindoos, washes the walls of Gorakhmadi Mat, and then proceeding on its course receives the waters of the Suri and Hiran rivers before emptying itself into the sea at Patan. About 3 miles south of Gorakhmadi is the very sacred Kund of Prachi. Here the River Saraswati takes an easterly course for a mile, called Prachi (east) in Sanskrit. Thousands of devotees come to bathe at Prachi to be cleansed of their sins, as the god Krishna is said to be ever present in the Kund.

Triveni.

The junction of the Rivers Saraswati, Suri, and Hiran is called Triveni, and is held very sacred. All good Hindoos after death, if burnt here, are happy, as the god Krishna after his death was burnt here.

Roads.

There are only two made roads deserving the name, in the portion of country surveyed, and these are unfinished and not yet open for cart traffic. One road is from Porbandar to Ranawao, which is to be extended to Kuntiyana, and thence to Dhoraji and Rajkot; and the other from Verawal to Junagarh which passes through sheet 49. There are cart tracks from village to village, but, owing to the rocky nature of the country, they are perhaps the worst that can be imagined.

Travellers' bungalows.

There are no travellers' bungalows in the district. There is a bungalow at Porbandar, and there are two at Verawal, built by the Chiefs of Porbandar and Junágarh, but they are intended for the Political Officers of the district, and are only available for travellers when not required by them.

Locomotion.

Carts are the principal vehicles for locomotion and traffic. In the Gir, camels, bullocks and buffaloes are used for carrying burdens, but even in this wild tract of country cart-roads are found, the one most extensively used being that from Ghantwar to Manakwara.

Trees.

No good timber trees are seen; the teak, "sag," grows in the Gir, but it is very stunted, and is only used for scantlings of huts. The ebony ("temberwa") and blackwood, ("sisu") are also obtainable, but in small quantities and of small girth. The larger trees are the "bar" (*Ficus indica*), the "pipal" (*Ficus religiosa*), and the "babul" (*Acacia arabica*). Of these, every village has its "waris" studded with them. The "palas," or bastard teak, grows in the Gir and Bardas, but seldom attains a greater height than 15 feet. Here and there a few mango and tamarind trees are seen, as also a few cocoanut palms. The date palm grows luxuriantly on the borders of some of the smaller rivers, but the people never tap the trees for toddy, and the only use they are put to is for making brooms from the leaves.

Minerals.

Iron ore is found in many parts of Garda and Hállár. At Bakharla (a village belonging to the Porbandar State) there are many iron mines, but these have been abandoned on account of the want of fuel for smelting the ore.

Domestic animals.

The bullocks of this part of Kattywar are not as good as those met with in other parts of the country: cows and buffaloes are numerous, and some of the large cows and buffaloes obtained in the Gir are very much valued for the quantity of milk they yield. Horses are also numerous, but the breed is generally small, and not so much prized as those of Kattywar proper. Sheep of a large breed, and generally white, are seen in flocks of 100 and upwards, grazing with a large kind of ass, also white in colour, in the waste lands of every village. Camels are only seen in the large towns, but they are very inferior to the camels of Marwar.

Wild animals.

Of wild animals, the lion ("sawaj"), the panther ("dipra"), jackal ("sial"), the fox, and wild cat, are found in the Gir, as also the sambar, nilgai, and chital; the common red antelope and the black buck are seen in herds almost everywhere. The jheels and tanks

are in most places full of duck, snipe; and other game, and the common partridge lurks in the village hedges, and the bush and grain quail in every field. Wild hogs are seen in abundance in the Gir and other woody spots. Along the sea-coast and in creeks the flamingo, curlew, and gull may be seen in flocks, mingled with spoonbills, ibis, and other birds.

Extract from a Report, dated 10th August 1878, of CAPTAIN R. G. WOODTHORPE, R. E., *in charge, North Brahmaputra Exploration Topographical Survey.*

3. I joined Lieutenant Harman at North Lakhimpur on the 29th November, and on the 3rd December we started for Pathalipam, a tea-garden on the Subansiri River, about 6 miles from the foot of the hills. Lieutenant Maxwell, Assistant Commissioner of North Lakhimpur, accompanied us by order of Colonel Keatinge, as he had been into the Miri Hills before and had met most of the headmen with whom our work would bring us into contact. Moreover, his character of distributor of *"posa"* ("black-mail" or "annual allowances") to these tribes gave him a certain amount of influence over them, which neither Lieutenant Harman nor I could have hoped to acquire. At Pathalipam we picked up our escort composed as in the margin. Godowns had been built here and provisions stored, and on the 6th December we started into the hills, and climbing over the low steep outer ranges descended again to the banks of the Subansiri, where, at a spot called Ganditula, 6 miles in a straight line from the plains, we established our second depôt.

44TH SHILLONG LIGHT INFANTRY.
1 Jemadar.
2 Havildars.
1 Naik.
22 Sepoys.

LAKHIMPUR POLICE.
1 Sub-Inspector.
1 Head Constable.
23 Constables.

4. Ganditula (*Graudi*, a bug, *tula*, to lift) is so called from the number of large bugs found among the stones: these bugs are highly prized by the aborigines, even by such a civilised race as the Khamtis, for the peculiar flavour which the presence of a few in the cooking pot imparts to their curries. Ganditula is a large triangular space of sand and stones running back from the river and sheltered by the surrounding hills, and affording an excellent site for a depôt, as it is easily accessible by boat from Pathalipam. While getting up our supplies and some of the escort whom we had been compelled for want of carriage to leave behind, we made a two days' trip up the Subansiri to ascertain the practicability of a route along its banks to Sidang Mukh, a point it would be desirable to reach at some time or other in the prosecution of our work. Lieutenant Maxwell succeeded in securing the services of a large number of Miris who arrived at Ganditula on their way to the plains, and by them we sent up a store of provisions to Bini village, two days' march for laden coolies from Ganditula. When the escort arrived and stores for three weeks had been collected at Ganditula, we felt justified in moving on to Bini: this village is at a height of 3,350 feet above sea-level, and is situated on the northern slopes of the first high range from the plains. On this range Lieutenant Harman wished to establish a couple of Great Trigonometrical stations. To reach Bini from Ganditula the path crosses this range over a comparatively low portion called Moira at a height of about 5,300 feet. Lieutenant Harman found two points well suited for his work: one called Yellu, four miles as the crow flies, due south of Bini, with an elevation of 7,466 feet; and another Pidi, three miles east of Bini, with an elevation of 6,327 feet. The former was troublesome to get to, and there was no water accessible near the top; so while Lieutenant Harman was camped on the hill (about eight days) he had to send some four miles down, 3,000 feet, daily for water. Yellu was a difficult hill to clear, being broad and flat, but the views from it were magnificent, when the clouds lay like a calm white sea over the low country and in the valleys, marking the courses of the great rivers, the higher ranges standing up clear and sharp in the cold morning air, the distant horizon to the north shut in by the dazzling brightness of the lofty snowy peaks of the Himalayas. Looking north-east and east towards the so-called and dreaded Abor country, so unbroken was the cloudy sea, that it was difficult to believe that we were not looking over the plains, so low are the hills forming the watershed in that direction, their average height being only 4,730 feet, and the pass from the Miri country into that of the Abors must be 1,200 feet lower than these peaks; and it was not till the sun asserted his power, and the fogs rose and dispersed, that we saw all the little broken ranges composing the "Abor" territory through which flows the Dihong River. Lieutenant Harman, from observations made from the banks of the Brahmaputra in former seasons, had arrived at the conclusion that the hills enclosing the valley of the Dihong are low, and the justness of his conclusions was proved from Yellu. Due north, higher, near ranges shut out the view of the snow, but from north to east we could see them clearly, and the fogs enabled us to trace approximately the course of most of the tributaries of the Subansiri. The view from Pidi is very similar to that from Yellu, and discloses scarcely any new country.

5. By Christmas day, when the Rutum people gave us a mithan, our work from Yellu was finished. Lieutenant Harman then went up to Pidi, thence to a high point called Dicho, on a spur from the Yellu range, about 7 miles due north of Yellu, a very useful point. While he was doing this, I accompanied Lieutenant Maxwell to the village of a headman called Tegli, a very friendly, well-disposed man, who gave us another mithan. This village turned out to be further off than we had been led to expect, and to reach it we had to cross the "Dicho" spur, over a high peak called "Jatto," at an elevation of 8,200 feet. We crossed it on the

28th December, a fine clear day; a few days after the weather changed, and snow fell to the depth of a couple of inches. Teglis village overlooks the Kamla River, one of the principal branches of the Subansiri, mentioned by Wilcox. Finding that the people on either side of the Kamla were well disposed towards us, I determined to make a few days' trip across the river, in order to explore more fully the country on the left bank, and to endeavour to get a better knowledge of the country to the west of Teglis, which was invisible from his side of the river. In order to do this, I had to get up fresh supplies from Bini, and we halted at Teglis till the 4th January. The weather was very bad, dense fog or rain preventing me from doing much. On the 3rd our supplies came in, and with them Mr. Robert, my Assistant, who had been surveying the country in rear of us. On the 4th our camp was sent off early, and we were preparing to follow, when I was suddenly seized with so severe an attack of fever and sickness that I was unable to move, and remained behind, Lieutenant Maxwell and Mr. Roberts going on. I hoped to have rejoined them later on in the day, or next morning, but I was too weak to do so, and had to remain in camp till they returned on the 10th January. The Government instructions had been very precise as to the limits of our explorations, so I did not feel justified, apart from the difficulties of food and carriage, in pushing our work further in the direction of the sources of the Kamla; but had Government permitted it, and the orders been conveyed to us early enough to have secured a proper coolie establishment, I see no reason, as far as the disposition of the tribes goes, why we should not have penetrated to the snows. An exploring party to be successful must be quite independent of the natives, and we could have got very little assistance from the people on the left bank of the Kamla either in the way of carriage or food (having hardly enough of the latter for themselves), but I do not think we should have met with any active opposition.

6. On the 11th January we returned to Bini *vid* Dicho, picking up Lieutenant Harman there. He had been detained on this point for eleven days by bad weather, which had prevented his seeing anything of the distant ranges till the day before we met him. We reached Bini on the 16th, and returned to Ganditula to make arrangements for a reconnoissance of the country east of Sidang Mukh. Lieutenant Maxwell left us on the 20th for the Naga Hills to our great regret. He had proved himself a most agreeable companion, his services had been invaluable to us, and our thanks are due to him for his cordial and ready co-operation.

7. Our arrangements were completed by the 23rd, and we started up the Subansiri, taking two boats with us. The banks are steep and rocky in some parts, bouldering in others, and difficult in all for our laden coolies, but they managed to get along fairly well. The rapids are numerous and dangerous, and much care and skill were needed to get the boats safely over them, indeed, at one we lost a boat on the second day. On the 24th at midday we reached Sidang Mukh, and halted for the night; next day, leaving our camp standing, we walked to the nearest village, a Ghasi Miri village, the son of the headman of which had accompanied us from the plains. We arranged through him for a certain number of Miris to go down the following day to carry our baggage up to the village, and in the evening we returned to our camp. Having secured these Miri coolies, we were able to send thirty of our men back for supplies; we also sent for more boats to come up. On the 27th we moved camp to the village which is situated in the valley of the Sidang, though not on its banks, lying about two miles from the right bank of that stream at an elevation of 2,000 feet only. The valley of the Sidang is enclosed between lofty hills, those to the north rising to 6,000 and 7,000 feet, and it was necessary for us to clear a point on this range in order to see the country beyond. A very good point called "Potu" was accessible from the village, and this we ascended and cleared, *i. e.*, Lieutenant Harman and I, while Mr. Robert with a small escort continued his journey towards the head of the Sidang to get in the detail of the valley. Bad weather detained us for 6 days on this hill, and then leaving Lieutenant Harman's Assistant, Mr. McCarthy, who joined him on the 6th February, to finish the work of observing there, we made an excursion across the range to the valley of the "Seu," a fine stream coming down from the snows, east of the Subansiri. We arrived on the 9th February at a village called Marniu. From this village we had hoped to have been able to make a trip across the range above, from the other side of which we ought to have obtained an excellent view of the country between Marniu and the snows. Fate, however, was once more against us; rain poured in torrents for most of the time we were there, and even in the few intervals when the rain was not falling, heavy fogs shut out the view yet more effectually. We remained three days in the vain hope of a break, and then, being unable to get any supplies for our men (beyond a couple of mutilated pigs, which the Khasias relished exceedingly), and our own store running very low, from the wearying delays the weather had occasioned us, we were compelled to return to our standing camp at the Ghasi village. Here we found that Mr. Robert had been very successful in his work, and having finished it had gone on to Pathalipam, as I had requested him, in order to leave as much food untouched as possible at the Ghasi camp. We followed him to Pathalipam, arriving there on the 16th, where Mr. McCarthy joined us a few days later. Several boat accidents happened in shooting the rapids coming down. In one, Lieutenant Harman lost a good deal of his personal property, in another, two Khasia coolies with Mr. McCarthy, were unfortunately drowned. They were suffering from sore feet, and Mr. McCarthy put them into a boat. Khasias are not accustomed to boats, as a rule, and on approaching a dangerous looking rapid they lost their heads and jumped out of the boat, were swept away, and never seen again.

8. At Pathalipam Lieutenant Harman and I parted company; my work for the rest of the season taking me to the Dibong River and the Mishmi Hills, while Lieutenant Harman proceeded to measure the discharges of the Rivers Subansiri, Dihong, Dibong and Brahma-

putra, and complete the triangulation at the head of the Assam Valley. Before proceeding to treat of the Mishmi work, it will be well here to sum up the results of the Miri Hills exploration, and give a short account of the country and people.

9. As before mentioned, we were prevented by the strict orders of Government from following up the exploration of the Subansiri as far as was necessary to declare positively that the Sanpo does not find its way through the snows into that river. That the Subansiri rises behind the high snowy peaks seen from Tezpore and the Brahmaputra, I think very likely from its size and velocity; but its volume is only one-fourth of that of the Dihong, which we consider most likely to be the outlet of the Sanpo. If the Sanpo does not add its waters to the Dihong, it must either fall into the Subansiri, or, passing along to the east, fall into one of the large rivers flowing through China. Neither of these suppositions commends itself to us; for, in the first place, we do not consider the Subansiri large enough to contain the Sanpo; and, in the second place, if it did flow into China, it would restrict the drainage of the Dihong to an absurdly small area. Mere theories on geographical questions, however, apparently well based on observation, have so often proved false, that it will only be by a much more extended exploration than we were able to make that the much-vexed question of the course of the Sanpo will be finally set at rest. The actual results of our work are that we have accurately defind 1,500 square miles of country on the scale of two miles to the inch, and obtained a fair knowledge of about 400 square miles on a smaller scale of country besides that actually visited and mapped on the larger scale.

10. The ranges of hills run more or less parallel to each other east and west of the Subansiri; the outer range is generally low, rising to about 3,000 or 4,000 feet at some points. Immediately behind this range, though the hills rise at once and very abruptly to 6,000, 7,000 and 8,000 feet, they are densely covered with large forest trees, bamboo and cane jungle, and quite uninhabited on the southern slopes, the nearest villages to the plains being at least 12 miles as the crow flies from the foot of the hills, the paths being few, obscure, and very steep and difficult, especially after rain, when they are so slippery as to be almost impassable. The ridges are all remarkable for their exceeding sharpness, in some places being so narrow as barely to afford foothold. The way to "Potu" led up one of these, and here and there, where a tree forked from the ground, it was necessary to step between the boughs, the ground being too steep to admit of our passing round the tree. Water at low elevations was very plentiful and accessible; but, as I have had occasion to remark before, it was very difficult to find and often quite inaccesible near the summits of the hills, and at Yellu, Dicho and Pôtu, the coolies had daily to make a descent of from 3,000 to 4,000 feet to take up water for the camp. Beyond the Kamla and the Seu Rivers to the north, the country seemed much more open, as regards the lower spurs, villages are comparatively numerous, and the paths more frequent, open and better made. The rivers abound in fish, which attain a large size in the Kamla and Subansiri, and it is not an uncommon thing to land a 50lb *Mashcer* from the Subansiri, near Pâthalipam. Within the hills above Ganditula we caught one weighing 26lbs. Game is plentiful, such as deer of various kinds, sambar, barking deer, ser, &c., bears, elephants, &c.; but from the denseness of the jungle they are seldom seen, though the barking deer's cry is heard all day and night close to the villages. The Subansiri* is a noble river in the hills, and the gorges through which it emerges into the plains are singularly fine; the banks formed of precipitous masses of rock, enclosing deep pools in which measurements give a depth of 70 and 80 feet; the river is about 70 yards broad at Ganditula, and flows with great velocity. I have already mentioned the rapids which increase in number and violence up to Sidang Mukh, beyond which it is navigable for only a few miles. During the cold season Lieutenant Harman calculates that at least 9,000 cubic feet per second of its volume are derived from the country lying north of latitude 28.° The Miri bridges are built as follows: four suspension ropes formed of two or three strong canes each are stretched across the river over frame-works securely lashed to the trees near, in such a manner as to form the extremities of the axis of an elipse, the major axis being vertical, and about 6 feet high, the circumference of the elipse being obtained by bands of cane fastened at intervals of a few feet; to these suspension ropes a few thin canes or bamboos form the footway of this tabular bridge to which access is obtained by rude ladders. The bridge is generally suspended about 30 or 40 feet above the water.

*Called also "Hubanhiri" by the Assamese.

11. The Miris are a hardy race, of middle height, and very wiry; they are generally fair in complexion, and often ruddy in the cheek, in the case of young men and girls. Neither men nor women have much *pretention* to good looks. They have, as a rule, flat faces with high cheek bones, eyes slightly oblique and far apart, their mouths often very well cut. The men wear their hair drawn up from behind, plaited and tied in a knot in front on the forehead and secured with a bone, metal, or bamboo pin. A small fillet of leather studded with metal knobs passes round their head above the ears. The boys frequently wear their hair long and flowing, moustaches and beard are seldom seen, a few straggling hairs on upper lip or chin being all the hairiest can boast. The males, both young and old, rarely appear without their helmets, wicker-work hats exceedingly well made, and in shape somewhat resembling a hunting cap with the peak worn behind, the rim being carried at the back into a gracefully curved peak. These helmets are rather larger, but identical in shape with those of the Daphlas. A bushy piece of bearskin, a tuft of feathers, or a tassel of yellow grass is attached to the front, throwing a soft shade over the forehead. The pin which secures the topknot of hair passes through a small loop in front of the helmet and keeps it firm on the head. As ear ornaments, they

wear discs and cylinders of silver or other white metal, or small brass rings, and among the richer, large funnel-shaped metal ornaments, the large opening being to the front. Both men and women are fond of bead necklaces, and all smoke to excess from a very early age. Their pipes are of bamboo or metal.

12. The men's dress consists of a course cloth tied crosswise over their shoulders and hanging below the waist, another small cloth being passed round the waist and between the thighs. A large number of cane rings are worn round the waist by both sexes, falling down. Roughly made jackets of pieces of skin sewn together are also worn by the men as a defensive garment. The Miris manufacture a warm cloth of stout cotton, tags being left on the upper side in imitation of sheepskin. Many of the men wear a small band of finely plaited cane just below the knee. For arms they carry a long straight *dao* and a small knife, also a bow and arrows, and to the north of the Kamla, long spears. The *dao* is often as much as 3½ feet long, the handle is short, and to us the whole weapon seemed rather unwieldy and badly balanced. The sheath is made of a flat piece of wood hollowed out to receive the blade, which is kept in its place by three or four strips of cane. The sword hangs under the left arm and is suspended by a belt of skin or leather studded with cowries, a bit of the lower jaw of a tiger ornamented with blue beads or cowries forming a kind of clasp. A small knife having a sheath similar to that of the *dao* is supported by a string round the neck and hangs in front of the chest. The women part their hair in the middle, and either tie it up in a knot behind, or, dividing it into two long plaits, bring these up over the top of the head; their dress is composed of a narrow petticoat tied round the waist and a cloth tied diagonally over the breasts, though this cloth is not always worn. I have said that they wear a broad belt of finely painted or loose canes round the waist, some two or three bands of which can be dropped at pleasure behind as low as the knee, and thus confine the petticoat in going up hill and in other risky positions. Among these canes is a curious belt of leather, a couple of inches broad, studded with large and strong metal points, a most effectual safeguard against the too tender pressure of the lover's arm. When working in the fields the petticoat is frequently discarded for a thick and long fringe of grass, and in some places the men also wear a small grass apron in lieu of the waist cloth enabling us fully to realise the appearance of Adam and Eve when they first became alive to a sense of decency.

13. The people above described live to the west of the Subansiri. Those to the east, the Ghasi Miris and kindred tribes, differ slightly from the others in their dress and manner of wearing the hair, to which the men give a short basin-shaped cross. Across the "Seu" the men are perfectly naked as to their loins, a cloth being worn over the shoulders in cold or wet weather. The women have very little more round the waist than the cane rings already mentioned. These naked people are called Abors by the Miris, but are really a tribe of Miris, as far as we could make out, their dialect being the same as that of the Ghasis.

14. The Miri villages are all very small, 18 or 19 houses being a very large number; the average generally is 8 or 9. Large families living in each house, though one, the headman's of one village, gave shelter to forty souls. In Bini village there are four houses and in Ruttum seven, and these are the two villages that years ago boasted that they owned a hundred houses and could put a thousand warriors into the field against us if necessary. It has fallen to the lot of the Survey lately to prove the falseness of the pretensions of most of the tribes on this frontier with reference to their strength and influence, and I have little doubt that should once a survey be boldly carried out in the so-called "Abor" hills, it would be found that their inhabitants were far less formidable than the accounts they give of themselves.

15. The Miri villages are all built on the slopes of spurs from the main ranges, never on the tops of hills or in elevated positions, nor are they defended in any way against attack, which proves that, unlike the Nagas, they live at peace among themselves, and blood-feuds do not seem to exist. The houses are built on the slopes without any attempt at order or levelling sites. The houses are of the same construction all over the Miri Hills, the floor being raised from the ground on long posts, the walls are of bamboo matting, and the roofs thatched with cane or palm-leaves. Among the Miris on the west of the Subansiri the houses are placed at right angles to the direction of the slope, so that one *side* is further from the ground than the other; among those on the east the houses are parallel to the slope, and consequently one *end* is further from the ground. There is attached to every house a piggery, also raised from the ground. The granaries abound in the villages. Among the Ghasis we noticed a peculiar construction of granary which I have never seen anywhere else, one corner of the floor being sloped downwards for a couple of feet. We could not quite ascertain the object of this.

16. The Miris to the west of the Subansiri are great trappers, both of fish and animals, and set traps near every path. Each man has a certain hunting ground into which others may not trespass, and the peaks take their names from the owners of the hunting grounds in which they are situated. The Ghasis, &c., to the east are, on the other hand, great trackers of large game, which they follow up with great persistence for days through the dense and impenetrable jungle. They do not use traps except for fish; they cultivate very little, and are consequently badly off for grain foods; the Miris hunt or trap, and fish in the cold weather, and what they thus secure, after satisfying their immediate wants, is dried and stored away for the rainy season. They are altogether a miserably poor race and entirely lack the well-to-do appearance of the people and villages, which is so striking among the Nagas and Angamis in particular.

17. Leaving Pathalipam, Mr. Robert and I proceeded to Dibrugarh to arrange for the work in the Mishmi Hills. At Dibrugarh our guard was changed for a detachment of the 43rd Assam Light Infantry and a few police, as shewn in the margin. On the 6th March we started for Sadiya. On the morning of the 8th a case of cholera among our Khasias was reported to me early; it ended fatally, and another coolie was attacked before we marched. The place we were then in was a very unhealthy spot, and we therefore moved on to the banks of the Brahmaputra, where, in a good open spot, we pitched camp. The second case was also fatal, and a third man died during the night, notwithstanding an endeavour to stay the plague. The sick were encamped a short distance from the rest on an elevated piece of ground, and one or two men who were attacked, recovered. I did not consider it safe to take my camp into Sadiya, so leaving Mr. Robert in charge, I went in myself to see Mr. Goad, the District Superintendent of Police, who was to accompany us to the Mishmi Hills. I saw several Mishmi headmen in Sadiya, who had been awaiting our arrival. As all hill tribes have an especial dread of cholera, Mr. Goad and I thought it as well to send the Mishmis on ahead to wait for us at their villages. I made all the necessary preliminary arrangements with Mr. Goad, and returned to camp in the evening. Our men seemed better; there were no fresh cases; and on the 11th I moved camp into Sadiya, and we all went into the Dibong river and encamped about a mile above the stockade. Unfortunately, the hope that we had got rid of the disease proved delusive, for it again broke out. Safety for the rest of the camp was to be found only in constant movement, so having made what arrangements we could for the comfort of the sick, and leaving the Native Doctor in charge, we made a fresh start on the 15th March. Our coolies and elephants made their way along the banks, large supplies of provisions going up by boat.

43RD ASSAM LIGHT INFANTRY.
1 Subadar.
2 Naiks.
23 Sepoys.

POLICE.
1 Head Constable.
10 Constables.

18. The Dibong is a fine river, divided up in the plains into a regular network of channels through all of which it flows noisily, and with great velocity, difficult rapids occurring in quick succession. These retarded the progress of the boats considerably, and as we could not leave them, our marches were necessarily short. Heavy storms, moreover, caused the river to rise several feet, thus increasing our difficulties. The lands of the Dibong and its numerous islands are generally very open, large spaces of sand and boulders covered sparsely here and there with low scrub jungle only, enabling us to obtain a magnificent view of the hills. Travelling up in a boat, and landing frequently at convenient spots on either bank, I managed to get the course of the Dibong fixed very accurately. On the 21st we arrived at Nijam Ghat, the principal crossing of the Mishmis and Abors. It is just at the entrance to the hills, and the river is only navigable for about 3 miles further up, beyond which the rapids become very violent. Three days were spent in trying to get carriage from the Mishmis to take us into their hills, our own coolie establishment having been sorely reduced. Notwithstanding that Lakho, a Mishmi Chief, residing at the foot of the hills, 4 miles from Nijam Ghat, had promised at the Sadiya *Mela* to help us in return for some guns the Government had presented to him, and had boasted of being able to bring the traditional thousand men to our assistance, if necessary, in dealing with Abors, we were unable to get a single coolie. If they were afraid of cholera, I cannot say; but I think it likely that Lakho did not wish us to go on, if he could help it, and hoped to tire us out by delay. He is not by any means the influential Chief he makes himself out to be, and he frequently dilated on the difficulties and dangers of the road into the hills. My patience was exhausted by the 24th, and I determined to march the next day. I had just enough coolies to carry myself, classies, a guard of 20 men with the subadar, and supplies for every one for nine days; I was, therefore, obliged to leave Mr. Goad and Mr. Robert behind. The former remained at Nijam Ghât, where he constructed a stockade and godowns; while Mr. Robert, taking elephants, explored the low ground to the east, including the courses of the two principal streams, the Dikrang and Diphu.

19. On the 25th March I entered the hills. The path at first was easy, but gradually got worse, and on the second day was very steep and difficult for the laden coolies. In many places we descended or ascended 20 or 30 feet over sheer rocks, our only support, a long slight cane dangling over the face of the rocks, at other places roots of trees afforded the only foothold in the steep path, and frequently rude ladders led us up and down precipices, and slippery bamboos suspended horizontally by canes from above afforded an insecure footway round dangerous angles of rock. On the third day we reached a good camping ground on the slope of lofty hill, 9,000 feet in height, above the village of Akamba. I visited the hill on the 28th to see if I could take a portion of my camp up there, and found plenty of snow on the top, and a small spring of water not far from the summit. I returned to camp at night, and it began to rain at 8 P. M., and went on for 26 hours without a moment's cessation, quite precluding all idea of moving camp. I had sent back coolies to Nijam Ghât to bring up a week's supplies, and I was fearful lest this flood should hinder their return, as I knew several bridges must have been swept away, and we could hear the Dibong roaring along in its narrow valley 5,000 feet below us. I afterwards ascertained that it actually rose 16 feet in those 24 hours. The 30th was a fine day, so sending my jemadar with a few Mishmis and Khasias down to repair the bridges, I went up to the hill and cleared it. It was covered with small bamboos and stunted rhododendrons, and we had little difficulty in clearing it. Snow was lying among these trees on the northern slopes, to the depth of several inches, though it was the end of

TO ILLUSTRATE PARA. 20 OF CAPTAIN WOODTHORPE'S REPORT.

March, and the thermometer at Nijam Ghât, which we could see only nine miles away in a straight line, sweltering in the sun, registered a temperature at noon of 92° in the shade, the minimum temperature at night being 60°. On the hill the maximum was 58° and the minimum 39°. Again we had cloudy, showery weather, and I scarcely got a glimpse of the country around till the 2nd April. The sky was clear from a very early hour on that day, and at 7 A. M. I was on the hill top. The few clouds veiling the survey peaks soon cleared away, and I had a most magnificent view of a vast expanse of beautiful country on three sides, the snow-clad hills closing in the horizon. On the 4th I looked out over the valley of Assam, through the dark green and gold of which glistened like silver, the waters of the Dibong, Dihong, Senseri and Brahmaputra rivers. The hill turned out even a better spot than I had ventured to hope, overlooking the whole of the main valley of the Dibong, called Dimba by the Mishmis, and enabling me besides to form a fair idea of the courses of each of its principal tributaries. By 11 o'clock I had finished my work, and we all descended to where I had left my standing camp, and the next day we moved on to Chini village.

20. In the afternoon I went down to the Dibong, a descent from Chini of 1,800 feet, to see a curious kind of bridge I had long been anxious to meet with. It has been well described by Wilcox as follows: "A stage is erected at a considerable height above the water" (at Chini it was about 60 feet) "on either bank and well secured with large stones and canes made fast to neighbouring trees. The three" (or four) "canes composing the suspending rope, pass over well secured supports on the stages at either end, and are separately fastened to trees, so that should one of them prove not trusworthy, others still remain. Before the stages a number of loops hang" (on the suspension rope) "ready for use. They are made of a long cane coiled like a roll of wire. The passenger inserts his head and shoulders through one of these, and brings it under the small of his back." He then passes several loops of cane hanging from the ring under his shoulders and back of his head to support that part; two other strips tied at the lowest part of the ring are then passed upwards between his legs and tied to the upper part of the ring, this is to prevent him from slipping out of the ring if his feet slide off the rope. Then, throwing his heels over the cane, and using both hands and feet, he starts off. One of my two guides went across to shew me the way, and when he returned, and I intimated my intention of crossing, their delight knew no bounds; but they explained that I must make up my mind to go right across, as no turning short of that is possible, the passenger being only able to travel head first. The nervous part about this method of travelling is the knowledge that no help from others is possible, if anything should happen in the middle of the bridge. However, this is a far pleasanter mode of crossing rivers than would at first sight be imagined, and preferable to the tabular bridges of the Miris.

21. We were detained at Chini for 3 days by incessant rain and heavy hailstorms, and while here we were presented with a mithan by the headman; it was promptly killed, and kept the camp in fresh meat for some time. On the 7th we made a start eastward, and reached Mipu village a little before nightfall. Here we were very hospitably received. We had hoped to have reached Kaludes (also called Kalidoi) village in one march, but the paths were very bad after the heavy rain, and in some stony ravines they had been carried away altogether. In one ravine, the path had been obliterated for a distance of 100 yards, and the passage across the loose shale and rock was made yet more dangerous by sudden showers of stones shooting from above. The three days detention at Chini had exhausted our stores, and the weather was so uncertain, the early rains having apparently set in, that I determined not to take my camp on to Kaludes village, about 6 miles further on, but to leave it at Mipu and make an excursion to Kaludes the following day, returning in the evening. Kalude is a very influential Mishmi in his part of the world, far more so than Lakho, and he was very much disappointed that we were not going to stay a night or two at his village. He wanted to send men for my camp, and offered to keep all my people for three days on "(Job's tears)," a grain, the latter did not care about a bit. He said he would kill a mithan for us and any number of fowls if we would only stay, and I was sorry to be obliged, for the reasons before mentioned, to refuse his hospitality, and he had to content himself with killing a pig for Lakho, Chini, and the other Mishmis with me. This pig was caught, killed, scalded, skinned, roasted, and eaten in the short space of one hour and-a-half,—an incident worthy of a place in the annals of an Indian Dâk Bungalow. On the 9th, accompanied by Kalude, Lakho, Chini, &c., we commenced the return journey in a fearful downpour of rain. Fortunately we found all our huts at Chini standing, or the sepoys and coolies would have had a rough night of it. We reached Nijam Ghât on the 12th. I halted there on the 13th to take leave of the Mishmis who had accompanied me, making each a few trifling presents. Then sending off all the boats, heavy baggage, and spare men, on the 14th Mr. Goad and I set off to find Mr. Robert on the Diphu river. There are several remains of old forts along the foot of these hills, and in one called Bishomnagar, of which little but the gateways now remains, flourishes still a large tea garden, in which, notwithstanding that tall forest trees keep out sunshine and air, and tangled weeds choke the spaces between, the bushes are strong and healthy with good leaves. The Singphos from the Tenga Pani and Noa Dehing river go up in large numbers and collect the tea leaves yearly. These they dry and pound into bamboo tubes, which they carry about with them on their travels.

22. The Dikrang and Diphu rivers are full of fish of a very respectable size. On the Diphu, on the 18th, we picked up Mr. Robert, and on the 26th we all arrived in Sadiya, where cholera again attacked our camp, carrying off one of Mr. Harman's coolies and my office writer.

23. The Mishmis and their villages, &c., have been so well described by Wilcox, that I have little to add to his description. He makes a mistake in describing the Bebaja Mishmis as cannibals. Careful enquiry on my part elicited an indignant denial from the other Mishmis, who, however, describe them as very savage and blood-thirsty. The Mishmi villages are all very small and built low down on the slopes and in the ravines. The houses are very long, as much as 250 feet and 300 feet, and only 12 to 15 feet broad, in plan they are often curved to follow the direction of the nook they are built in, to save excavation. These villages seldom consist of more than four or five houses, 9 at the outside, as far as my experience went. The houses are scattered about in the ravines among the plantains and other jungle, which grows right up to the walls of the little enclosure in which they stand, and the traveller arrives within a few yards before he knows that a village is near, and it often happens that from no house in the village can one see any of the others.

24. The hills are all very steep, and water is more plentiful than I have seen it anywhere else. Looking across a valley to the slopes on the other side, one sees waterfalls in every little ravine, and travelling along the paths leading round the spurs, little torrents are crossed at every few hundred yards. The path not unfrequently follows the course of a stream undeterred by waterfalls, through the spray of which the traveller ascends with only such footing as is afforded by the wet moss-covered rocks, where the slightest slip would ensure a ducking and many bruises, if nothing worse. The Mishmis headed by Lakho had tried to dissuade me from entering the hills, by saying that my laden coolies could not possibly get along their paths. They probably fancied they were Assamese, men who certainly could not have gone the first mile, but my Khasins managed exceedingly well, and we had no accidents of any consequence.

25. The results of our work in the Mishmi Hills are (1) a fairly accurate knowledge of the sources of the Dibong and the course of its main stream in the hills; (2) an accurate knowledge of its course in the plains, and of about 1,000 square miles of the hills bordering it; (3) an approximate knowledge of an additional 1,100 square miles in the hills. The Dikrang, Diphu and Digaru Rivers are also now well known, and can be entered on the maps with confidence.

26. Before concluding, I would wish to make a few remarks on the Abor villages which we could see distinctly from the hill above Akumba. I could see Mebor, Situk or Dambuk, and Bomjur through the telescope, well, and could count the houses. None of them, even allowing for a few which might have been hidden in the jungle, seemed to contain more than 35 to 40; yet the native purveyors of information about these tribes to the civil officers put down the number of houses in each of these villages at figures varying from 50 to 250. Mr. Goad assured me that Dambuk contained 250 houses, and so did Lahmon, Inspector of Police at Sadiya; yet, from my hill top, I could only make out 40 at the very outside. I think, therefore, that, as I remarked in a previous paragraph (14), the size and importance of the Abor tribes may be greatly exaggerated.

27. A set of photographs by Mr. Robert who, amid his other arduous duties, found time to make this interesting collection of views and groups, accompanies this report, and will help to clear up much that might otherwise be obscure.

Brief account of survey operations in the "Jowaki Country" with the Expeditionary Columns under BRIGADIER-GENERAL KEYES, C.B., *and* BRIGADIER-GENERAL ROSS, C.B., *during 1877-78, Extracted from the Reports of the Survey Officers employed.*

Requisition for professional surveyors.

On the 7th December 1877, the Punjab Government telegraphed to Colonel H. C. Johnstone, Deputy Superintendent, in charge of the North-Western Frontier Survey, "to send, if possible, two Assistants competent to survey with troops in the field—one to join General Keyes, and the other General Ross." In accordance with this request, Mr. G. B. Scott was directed to join the latter, and Mr. A. J. Gibson the former. They joined, respectively, on the 18th and 20th December. Captain Beavan was subsequently sent on the 25th January 1878. As the two columns were distinct from one another, it will be well to detail the operations separately.

Independent territory occupied by troops.

The country in which the troops were operating, was the tongue of independent, mountainous country, situated in latitude $\frac{33° 32'}{33° 47'}$ and longitude $\frac{71° 30'}{72° 0'}$, with an approximate area of 300 square miles, having British territory on the north, south and east, and occupied by the large Afridi clan of Adam Khel. With the exception of about 50 square miles of the hills occupied by the Hassan Khels (being the most eastern portion contiguous to British territory), the whole has been surveyed on the 4-inch scale, with more or less minuteness of detail according as opportunities were given when the troops marched.

Mr. G. B. Scott's operations.

Mr. Scott joined the camp at Sarghasha on the 18th December; he was informed that it was unsafe for him to go any distance from camp, he therefore commenced by measuring two base lines in its immediate vicinity with the chain. He first connected these base lines with the Revenue Survey Station Tesakai fixed in season 1869-70, and then was enabled to fix three

NORTH WEST FRONTIER SURVEY

Surveyed by Messrs. G. B. Scott and A. J. Osborn.

Published under the direction of Colonel A. T. Walker C.B. R.E. I.S.S. Surveyor General of India.
Surveyor General's Office, Calcutta, January

Photozincographed at the Surveyor General's Office, Calcutta.

points about two miles apart from each other on the Sarghasha range, one being a tower 24 feet high, forming a prominent unmistakable landmark; from these stations a few prominent points were then fixed on the next range.

Any marks erected were thrown down.

For observations it was found impossible to adopt any signals or marks of any kind, as they were immediately thrown down and destroyed; advantage had, therefore, to be taken of peaks, trees and rocks, &c.

Advance from Sarghasha.

An advance made by the troops on the 31st December to Pastaoni village enabled observations to be made at Uchbori Sar, height 4,397 feet. From Pastaoni, by accompanying the skirmishing parties, the Walai-darrah river and adjacent hill slopes were surveyed for about three miles, when the enemy appeared in large numbers and threatened the escort, so that a return had to be made to camp from whence the survey was carried eastward, towards the village of Gorai. On the 2nd January the troops again returned to Sarghasha, where the Surveyor was enabled to furnish such maps as were required by the Quarter Master General's Department, as also to complete the ground round the camp; advantage was also taken of the removal of the restrictions to the extension of the survey in the Hassan Khel country, and in the Ashu Khel valley through which the Uchalgadda runs.

Reconnaissances during January.

An escort of one or more companies of sepoys having been given for the purpose, a second advance to Pastaoni on the 15th January enabled Mr. Scott to enter the course of the Walai-darrah, between Pastaoni and Walai. On the 17th he was joined by Mr. Gibson, when both visited the prominent peak known as Zersappar, height 4,684 feet, from whence observations were made to the "Kohat Kotul Fort," to "Matanni Dâk Bungalow" and "Chabutra Police Station." For some days they were able to work in combination. Angular observations were obtained at Mandahar Sar, height 4,472 feet; and at Dargai Sar, height 4,735 feet. This latter observation enabled a complete connection to be made with Mr. Gibson's work. On the 23rd January, Mr. Scott being permitted to accompany an escort of 600 men through the Bazid Khel valley, the position of Turkhi and other villages in that valley were fixed, and the hill slopes on either side were sketched. This force went on to Kohat the same night, so that an area of about 10 square miles in the southern slopes of the main range from a point five miles east of the Kohat Kotul was necessarily left unsurveyed. From Kohat a return to Sarghasha enabled the work in that neighborhood to be completed, and continued westwards in front of Fort Mackison to the Peshawur entrance of the Kohat Pass, also connections to be made with Great Trigonometrical Survey station Jelala Sar, and with Revenue Survey stations Oormar and Ispeenkhak of season 1869-70.

Mr. Scott's out-turn.

The area surveyed by Mr. Scott was 153 square miles. Theodolite observations were taken at 7 points within British Territory and at 13 points in Independent Territory, the position of 47 points, and heights above sea-level of 40 points being thereby fixed. The heights of 22 villages, passes, &c., were also ascertained by Aneroid Barometer readings.

Survey operations by Mr. A. J. Gibson.

Mr. Gibson, who had been at work in the Dera Ismail Khan District, joined General Keyes' camp at Shindih, in the Jowaki country, on the 26th December, and the next day commenced work by measuring two bases in the plain, which he was able to connect with Mundaher Sar, Durgai Sar, Zanguia Sar, and other conspicuous peaks; he then commenced plane tabling in the vicinity of the camp. An advance of the troops on the 31st enabled the ascent of Lunda Gharai, 4,196 feet, to be made, and the hills and drainage of the country on either side of the route to be sketched. Durgai Sar, 4,735 feet, was also visited, and the ridge sketched towards Zanguia Sar, 4,864 feet, descending by the spur to Ghariba, Shindih was reached at nightfall. During the next ten days, the country round Shindih and Turkai was surveyed, and Nerai Sar, 3,227 feet; Dadd, 2,490 feet, and some other points were fixed. On the 17th, as already stated, Mr. Gibson and Mr. Scott met and worked together for a few days; after separating, Mr. Gibson surveyed the Nara Khula river and a portion of the Jamu valley, also the Tortang and Sarra Ghunda valleys, as far east as Gholam Banda at the base of the hills. On returning to Shindih, as much as possible of the Paish Valley was sketched, also the Tambal Range; he then worked westwards and put in the main road between Gundiali Fort and village of Togh, where operations were closed on the 15th February.

Out-turn by Mr. Gibson.

The total area mapped by Mr. Gibson on the 4-inch scale was 100 square miles, the position and heights of 13 points having been determined by theodolite observations. Mr. Gibson, by order, returned to Rawul Pindi on the 20th February 1878.

Captain Beavan, Assistant Superintendent.

Captain Beavan was directed to proceed and join the field force on the 25th January 1878. Arriving at Peshawur on the 26th, he found that the greater portion of the Jowaki country had been evacuated. A small camp of observation still remained on the Sarghasha ridge; on arrival there he inspected Mr. Scott's work, and states—

"I believe the whole of it to be sufficiently correct for all practical purposes; the peaks and ridges are in their proper positions, and the general character of the country has been well delineated."

On the 29th, he proceeded to Kohat and inspected Mr. Gibson's work, which he states—

"I found remarkably accurate, and although he had not had the same opportunities of traversing so large an area, yet he had made up for this by the accuracy of all he had been able to do."

Captain Beavan returned to Peshawur on the 6th February, and commenced a complete trace of the Jowaki country for the Punjab Government and for the military authorities in illustration of the operations.

Survey of Kohat Pass.

The military authorities were very anxious that a survey should be made of the Kohat Pass, but political considerations stood in the way, and it was not until the 28th that permission was given to Captain Beavan to start; taking Mr. Scott with him, Kohat was reached on the 1st March. Starting from Kohat at day-break on the 2nd with the "Guides," a fairly accurate but rough survey of the Pass was made during the day; the hills on either side of the road were sketched, and the position of villages and other objects fixed. Near the village of Sheraki a determined objection was made to the chain being used, and as the regiment had marched on, the chaining had to be stopped till the troops were rejoined near Thahidi; from this point it was again resumed and continued to the exit of the Pass.

Captain Beavan reports that—

Personnel.

"The Brigadier-General, the Commissioner of Peshawur, and all the officers connected with the expedition spoke in terms of the highest praise of the energy shown by Mr. Scott on all occasions."

Captain Beavan and Mr. Scott returned to Rawul Pindi on the 4th March 1878.

Assistance rendered.

Brigadier-General Ross, the Deputy Commissioner (Captain Cavagnari), and Assistant Quarter Master General (Captain Trotter), gave Mr. Scott every possible assistance and information as to names, routes, &c. They constantly supplied escorts, and it is added that—

"Without their help, a square mile of country could not have been surveyed."

Extract from Annual Report of the Barkegark and Chota Nagpore Estates Survey, by CAPTAIN J. E. SANDEMAN, *Officiating Deputy Superintendent, season 1877-78.*

A telegram from Government to the Commissioner, Chota Nagpore Division, authorized the commencement of the survey of the Estate of Barkagarh.

The Commissioner's (the late Mr. Taylor) personal instructions were that the survey of the Estate should be pushed on and finished with as little delay as possible, irrespective of the Chota Nagpore Estate; hence, the strength of the establishment, as far as available and as early as possible, was brought to bear on this work. The telegram referred to above was received at the moment of taking the field.

All matters regarding the procedure to be adopted, had to be discussed during the field season as the work progressed.

As difficulties arose, I brought them to notice, and in your letter No. 49, dated 14th February 1878, I received final instructions to survey all rice "*kiaris*," (the average size of which I had estimated at ·15 of an acre) on the 32-inch scale, at the request of the Settlement Department. The general scale of the village survey was kept at 16 inches, wherever possible.

I had originally estimated for a survey of holdings only for settlement purposes, as this is the procedure adopted in the North-Western Provinces; *vide* also Board of Revenue Regulations, Chapter XX, Section 3, paragraph 14, and Chapter XXIII, Section 3, paragraph 9.

The Settlement Officer, acting on the authority of the late Commissioner, Colonel Dalton, argued that a "kiari" survey was necessary, and stated that, as a holding often consisted of two or three kinds of rice land; and that hereafter portions of a holding might change hands, the part could not be marked off without a re-survey. My reply was, that it was quite possible to survey the two or three different kinds of rice land in a holding, as they are distinct and easily recognized, the distinction depending on the height of the rice terrace; and that in case of a change of hands hereafter of portions of holding, that it would be found infinitely cheaper to send out an Amin to correct the record, than to survey thousands of "*kiaris*" for this purpose, which were mere divisions made to "bund" up water and submerge the rice. In fact, it was clear that a survey of the *field* or holding was not to be made, but one of thousands of arbitrary field divisions.

I mention the chief points of this discussion here, as I have been blamed for giving the civil authorities an erroneous estimate on insufficient data.

I trust I have shown that I could have had no reason for supposing that anything but a settlement survey, such as I had seen carried on in other provinces, would be required.

The Government of Bengal stated that the further survey of zemindari villages was unnecessary, *vide* letter No. 2291, dated 20th September, from Secretary to Bengal Government, to Board of Revenue; the calculation of field areas of such zemindari villages (14 in all), as had not already been completed, has been stopped. In the field, also, the moment that I heard from the Settlement Officer that certain villages did not require settlement, I

stopped their survey and referred the matter to you; thus only 10 zemindari and lakhiraj villages of the Barkagarh Estate were surveyed.

* * * * * * * *

The survey and comparison of the Buinhari or rent-free holdings have given great trouble and been a source of great delay, as every holding in the Buinhari maps had to be compared and passed with the identical holding on the professional village map.

The Buinhari maps are final and unalterable records, the two surveys seldom agreed, and the Amin had to be sent back time after time to correct the holdings as pointed out.

These holdings are supposed to be demarcated on the ground, but the demarcations were found very deficient; especially in rice holdings, the "Buinhars" endeavored to get the professional Surveyor to include more "*kiaris*" than they were entitled to, as was seen when the map came to be compared with that of the Special Commissioner appointed under the Chota Nagpore Land Tenures Act. As for six weeks the field establishment was employed in re-surveying and correcting these rent-free holdings, this alone has added several annas per acre to the cost of the work, especially if the extra work entailed in office in comparison is taken into account.

Mr. King was comparing and passing these holdings for three months, and Mr. Parker was so employed for one month.

The correct incorporation of these holdings into the professional maps adds greatly to their value.

In the original maps the holdings are often found out of position with respect to each other, but in the professional map the same holdings are in their true place, and can at once be recognized from the surrounding fields.

Extract from Descriptive Report by CAPTAIN E. W. SAMUELLS, *Officiating Deputy Superintendent, in charge of 10th (North) Deccan Party, season 1877–78.*

1. The general aspect of the Deccan has been often described; undulating grass-covered ridges and ranges of hills without trees or forest of any kind, only cactus scrub or prickly pear here and there. The geological formation is volcanic, and consists of alternate strata of amygdaloid and basalt. The country at one time and another has been flooded by successive waves of lava, some deposited above water, and others under water, and varying in degrees of hardness as they cooled rapidly or otherwise, the rapid cooling producing a compact glassy texture, and slow cooling the reverse. Many different eruptions may have occurred to form the present visible portion of the district, and long intervals of time probably elapsed between them, the surface of the strata in these intervals being denuded and formed into hills and valleys, into the hollows of which the succeeding eruptions have flowed. The basalt, being of a much harder texture than the amygdaloid, has better withstood these disintegrating influences, and the level table-lands of the hills and perpendicular cliffs are owing to their being composed of this rock, while the irregular slopes will be found to consist of the softer amygdaloid. The villages, as a rule, are situated in the valleys, compactly built, and surrounded by a bastioned wall with gateways. There is generally some garden land in the vicinity of the villages adjoining the banks of streams, either watered from wells or from the stream itself by means of "*bandhuras*" (earthen embankments). Fine mango and tamarind trees are often seen, which help to redeem the otherwise desolate appearance of the country.

General aspect of country.

2. Several hill forts are dotted about the country, some situated on isolated hills like Narayengarh near Juner; others on the bare plain itself, like the forts of Ahmednagar, Kharda and Chakan, but more frequently on the higher spurs and ranges where some hardened portion of basalt has resisted the disintegrating process and formed an almost ready-made fortress. These are more numerous on the ranges near the Ghâts, or on the edge of the Ghâts themselves, guarding the different passes between the Konkan and the Deccan. The most important is the Harischandragarh, situated in Sheet No. 8. Following the line of the Ghâts south, we come in succession to Judhan, a large fort; and further on, and Manchand and Ghorakgarh commanding the Copoli Ghât, and still further south, Sidgarh on an almost inaccessible spur jutting out into the Konkan. East of Judhan are Chawand, Hursur and Sewner, all large forts commanding the road leading to Nana and Malsej Ghâts, formerly one of the great outlets from the upper country into the Konkan.

Hill forts.

3. Sewner, situated about 2½ miles south-west of the taluka town of Juner, is interesting as being the birthplace of Sivaji, the famous Mahratta Chief, who was born there in 1627. The fort was granted in 1594 to Sivaji's grandfather, Maloji Bhonslay, and being an important one, was frequently taken and re-taken by Moghals and Mahrattas. Baji Rao, the last of the Peishwas, and his two brothers, were also kept there in confinement by Nana Farnawis in 1796, till the intrigues consequent on the suicide of Mahadu Rao Peishwa made it expedient for the minister to release and place Baji Rao on the musnad. There are five gates to the fort, and excellent water contained in tanks of great depth. Inside are the extensive ruins of large and solid buildings said to have been the Rajah's palace, and at the north end are the remains of a fine building called Bibichawara, or ladies' apartments.

Sewner Fort.

Harischandragarh Fort.

4. Harischandragarh is situated on the very edge of the Ghâts, about 4,000 feet above the Konkan; there is a magnificent scarp of 3,000 feet, nearly perpendicular in height. The fort itself was almost inaccessible, and required nothing in the way of a gate or fortification to defend the path by which it was approached. About 500 feet lower than the fort there is a rather extensive table-land, on which are the ruins of several tanks and temples; also a small but comfortable set of caves, which are used as residences by the district officials and others when they visit the locality. There is plenty of good water near the caves, and a carriage road through Juner to Karanjali at the foot of the hill.

Hill ranges.

5. The drainage from the Ghâts is all to the eastward; the rivers all flow across the Peninsula into the Bay of Bengal. The enormous rainfall that breaks on these Ghâts during the south-west monsoons has worn deep precipitous valleys, which have eaten their way back to the very watershed, leaving flat-topped spurs between them, which stretch far out into the Deccan, forming the watersheds between the different valleys. Commencing from the north, the Harischandra spur which separates the valleys of the Mula and Pashpatawati rivers—the former of which flows into the Godavari, the latter into the Bhima—runs in a south-easterly direction for about 50 miles to Parner, where it branches into two; one branch continues south-east past Khanpisura into the Sholapur district to the junction of the Bhima and Sina rivers; the other passes round the head of the Sina valley, north of Ahmednagar, and then turning south forms the watershed between the Sina and Godavari valleys. The average height of the Harischandra spur at the Ghâts is about 4,500, and the valleys on either side 2,500 feet. The next spur is a short one and only extends abouts 25 miles; it divides the valleys of the Kukari and the Mina, and ends abruptly at Narayengarh. A broad, flat-topped, and well cultivated spur, with an average height of about 4,000 feet, separates the Arr and Ghor rivers and extends as far as their junction to Pargaon, about 35 miles. The spur between the Ghor and Bhima rivers is the best cultivated and covered with numerous villages. It is not so high as the other, having an average height of about 3,000 feet.

Bhimashankar.

6. At the source of the Bhima, and close to the edge of the Ghâts, is Bhimashankar, where there is a fine temple and some tanks enclosing the springs which form the source of the Bhima. It is a place of pilgrimage: a small fair is held there annually in March. In front of the temple, suspended from an iron bar supported between two masonry pillars, is a very fine bell, weighing some three or four cwts. It has a Maltese cross marked on it, with the date underneath, 1727. The priest said it had been brought from Wasind (in the Konkan) in the Peishwa's time, and was probably looted from some Portuguese church or convent. This spur widens out considerably; and at Peint, about 30 miles from the Ghâts, where the Poona and Nassik road crosses it, it is a fine broad plateau, some four or five miles across, about the same elevation as Bhimashankar, and would make a capital site for a cantonment. The plateau extends south-east, in a well defined range almost to the junction of the Bhima and Ghor rivers, about 50 miles from Peint.

Want of trees.

7. These hill ranges and spurs, though flat and undulating on top, are cut up and intersected by very deep *khads* or ravines, as, owing to the tremendous rainfall, every small water-course cuts a deep channel for itself. The heads of these ravines nearly meet in some places, leaving only a narrow neck of land just wide enough for the road. The forest and jungle that once covered these Ghâts have been almost entirely destroyed; here and there a clump has been left round an old temple, or for some superstitious reason, sufficient to show what it must once have been. Magnificent large trees, chiefly mango and jamun (or jambul as it is locally termed), festooned with enormous creepers grow as luxuriantly as in any forest in Assam or Central India. Besides these few clumps there is nothing that can be called forest; here and there on the edge of the Ghâts there is dense scrub jungle but no trees; and in consequence of the jungle being destroyed, the heavy rainfall has washed away the soil, so that it will be some considerable time before it can again support forest.

State of the country in 1803 to 1818.

8. When the British Government took possession of the country, much of it was nearly ruined, and since the famine of 1803 a great part had been almost entirely uninhabited. As examples of the state of the country, it will be enough to state that in 1803 only 21 villages out of 180 were inhabited in the Newasa Taluka of Ahmednagar. In other parts of the same Collectorate in 1819, more than half the land was waste, and the country round Sirur was all jungle. The city of Ahmednagar contained in 1818 a population of 13,000, and in three years the number was almost doubled; it now contains 30,000 inhabitants.

Ahmednagar City and Cantonment.

9. The lands around Ahmednagar are of considerable fertility, and watered by numerous streams which take their rise in neighboring hills and combine to form the Sina. The valley is skirted by much hilly and broken ground: in the north and north-west the hills rise to a considerable height, and from them a fine view of the valley of the Godavari, as far as the Adjanta and Ellora ranges of hills, can be obtained. The city of Ahmednagar is enclosed by a mud wall and bastions and built close to the Sina river; on the north are the Native Infantry and Civil lines. The fort is half a mile east of the city, surrounded by a high stone wall and

bastions, with a deep ditch and glacis. The ditch is about 30 feet deep and 100 feet broad, rivetted with stone and was capable of being flooded, the water being brought by stone aqueducts from the neighboring hills. The entrance to the fort is a large double gateway on the north side; there is also a postern on the south side. The area of the fort inside the walls is about 52 acres. There are some substantial old buildings in one corner, now used as a magazine, Public Works and Commissariat offices, and another building contains the station library and recreation rooms. The European Infantry and Artillery barracks are a mile east of the fort, on the opposite bank of the Bhingar nala. The road to Poona crosses the Sina about a mile from Nagar by a fine iron girder bridge, and half a mile further on is the Railway station on the new Dhond and Munmar Railway which was opened last April.

Sirur Town and Cantonment.

10. Sirur, a military station and cantonment, and the head-quarters of the Poona Irregular Horse, is situated on the road from Poona to Ahmednagar, about midway between these two places, on the banks of the Ghor river. A brigade of the British subsidiary force, which was raised in 1813 by Baji Rao, was stationed here. The Poona and Ahmednagar road crosses the Ghor river by a fine stone bridge of 17 spans, which was built in 1867-69 at a cost of 1,04,000 rupees. The population is about 7,000, and there is a weekly market held here, at which a good many cattle are disposed of, besides the usual retail traffic in cloths and other articles. Some of the Sowears also export large quantities of grain.

Kurdeh Town.

11. In the valley of the Sina is the large market town of Kurdeh, which has a population of about 7,000, and is a very thriving place. There is a considerable trade in grain and other articles, which are procured from the neighboring villages and exported to Poona and other places to the westward. There is also a large cattle market. Close to the town is a small fort well built of stone, in which the Nizam shut himself up on being defeated by the Mahrattas in 1795. He was obliged to surrender after two days, and before being released from the trap into which he had thus ventured, had to cede the fort of Daulatabad and large tracts of territory, besides giving up Mashirul Mulk, his Prime Minister, into the hands of the Mahrattas.

Chief roads.

12. On the road between Poona and Nasik, the large rivers are left unbridged, but the rest of the road is bridged and metalled throughout. The road from Poona to Ahmednagar is also bridged and metalled, and there are excellent staging bungalows every 16 miles. This road is continued through Ahmednagar to Aurangabad and is bridged except at the large rivers. There is also an excellent metalled road from Ahmednagar to Tisgaon, over the Karanji Ghât, which is continued to Pytton in the Nizam's dominions; another good metalled road runs from Nagar through Rahuri, over the Nimbadehra Ghât, to Nasik and Mallegaum on the north, and from Nagar to Karmalla, Pandharpur, and other places on the south. There are also excellent cart roads in all directions passable for ordinary country carts and pony tongas. There are no cart roads through the Ghâts to the Konkan. One was constructed over the Malsej Ghât as a famine work, but was impassable after the first shower of rain. Cart roads run up all the principal valleys to the face of the Ghâts; the traffic over the Ghâts is carried on pick-bullocks.

Manufactures.

13. In most of the large towns there are looms for the manufacture of coarse cotton cloths; and the Dhangars weave blankets, the wool used being obtained from the sheep of the district. In Ahmednagar and the neighboring town of Bhingar, there are about 1,400 looms kept at work in the manufacture of *saris* and other cotton cloths. Some of these are of a superior description, and have an edging of colored silk, or are made of half silk and half cotton. The raw silk is imported from China to Bombay, and bought in Bombay by the local merchants; the price of the raw silk is nine rupees a pound. No country silk is used; the cost of it would be about half that of the China variety. The silk is spun into thread, dyed by the Sowears and sold to the weavers, who mix it with the cotton thread, or weave it into edgings for *saris* and *langotis*. No entire silk cloths are made in Nagar. An attempt was made to rear silk-worms many years ago in 1840 by a Major Byne, who rented the Feriah Bagh from Government and planted a number of mulberry trees. The trees flourished and are there still, but the experiment did not pay and it was given up. There is also a large manufacture of brass cooking-utensils in Nagar, besides other minor manufactures of carpets, numdahs, &c. In Kurdeh there are also about 125 families of weavers, who manufacture coarse cotton stuffs chiefly from country thread.

Village community.

14. The headman in a Deccan village is a Patel, and next to him comes the Kulkarni. These appointments are hereditary and generally held by Mahrattas. Every family of Patels and Kulkarnis has two or three members either enrolled or connected in some way with Scindia's or Holkar's army. There is frequently an assistant to the Patel, called a Changala, who always remains in a subordinate position.

Castes.

15. The majority of the population are Mahratta Kunbis. Another agricultural caste is that of the Malis, who more especially cultivate garden land. The Dhangars are also a numerous caste; many of them have settled down and cultivate land, and many wander about with large flocks of goats and sheep. A considerable portion of the population is occupied in manufactures of the commoner kinds—Salis, Koshtis, Khatris, and Momins (a class of Mussulmans),

are all employed in weaving. Dhangars and Mangs make the coarse blankets used by the lower classes. There are Mussulman and Hindu dyers or rungaries in the larger towns. Among the workers of metal, there are Sonars or goldsmiths, Kasars or Tambats, coppersmiths, Watars or casters, Lohars or blacksmiths, and Ghisadees or workers in steel, who are often Mussulmans. There are several castes employed in leather manufactures—Chamars or tanners and shoemakers, Saltangers who dye leather, Dhurs who are also tanners, Jingars who make saddles, harness, &c., and Katars who work in leather. These castes are all held in low estimation. Brahmins are scattered all over the country as Government servants and writers, and considerable numbers are found in the larger towns engaged in trade. The majority of the traders come from the other parts of the country. The most prominent are the Marwaries found in every village of any size and congregated in large numbers in the towns.

Wandering tribes.

16. The wandering castes and aboriginal tribes form a considerable portion of the population. The most important are the Bhils who are spread all over the country as far south as Ahmednagar. There are the hereditary Jaglias or village watchmen. Though now quiet, they do not become good farmers; they are improvident and lazy, and prefer a wandering life, and shooting and fishing, to any more settled employment. Ramosis are also in considerable numbers as Jaglias or watchmen; they were formerly notorious for their gang robberies, and even now, though as a rule quiet, they retain a liking for their old pursuits. The Wanjaris or Brinjaris are a numerous tribe and still employed in large numbers as carriers. They go down to the sea-coast with grain, tobacco, &c., carried by large trains of bullocks, and bring back salt; inland their carrying trade has, however, been sadly interfered with by the Railway, and many of them have settled down to agriculture and live in the villages like other cultivators, while the women also have given up their picturesque dress. There are several other wandering classes who all more or less combine stealing with some handicraft, such are Pardhis or sharers of game, Wadars or stone-masons, Pathrawats or quarrymen, Beldars employed in building houses, Gopals who are jugglers, and Chitrakatis who sell buffaloes. All these castes are often included in the common name Bhamtia. The low castes, who reside in the villages as village servants, are Mahars, Mangs, Kolis, Bhuis and Kahars, who are fishers and watermen by trade.

GEOGRAPHICAL COMPILING AND DRAWING BRANCH, SURVEYOR-GENERAL'S OFFICE.

Statement shewing the nature of the work performed, and the progress made, from 1st October 1877 to 30th September 1878, twelve months.

MAPS, &c.	SCALE.	REMARKS AND PROGRESS.
	Miles. Inch.	
INDIA—6 sheets (outline and names) ...	32=1	Sheets 1 and 4, hills in progress, on dry print proofs. Sheet 3, Rajputana, compiled and completed in outline to extent of survey. Under examination for engraving. Sheet 6 in progress.
INDIA, No. 3—4 sheets (outline and names,)	64=1	Dry print proofs of outline under completion and revision to date. Hill drawing completed on a complete copy for lithography.
BENGAL—2 sheets (outline and names)...	16=1	New names and sites inserted on dry print proofs agreeably to the new spelling.
PUNJAB—4 sheets (outline and names) ...	16=1	New compilation embracing recent surveys to date. Sheets 1 and 2, drawing in outline in progress, for engraving.
ASSAM—9 sheets ...	8=1	Sheets 3 and 6 compiled and drawn complete with hills. Further additions to date from recent surveys inserted in sheets 4, 5, $\frac{7 \text{ and } 8}{\text{in one}}$ to complete, being lithographed.
ASSAM ...	16=1	Blank portions filled in, and hills drawn on a dry print proof for lithography.
RAJPUTANA AGENCY—2 sheets (outline and names).	16=1	Further additions to complete, made on original compilation from recent surveys to date. Hill drawing in progress on mounted silver print. Engraving.
CENTRAL INDIA AGENCY—2 sheets (outline and names).	16=1	Further additions to complete, made on original compilation from recent surveys to date. Hills to be drawn for engraving.
CENTRAL PROVINCES—2 sheets (outline and names).	16=1	Compiled and drawn in outline from recent surveys to date. No hills for engraving.
NAGA HILLS—Sketch map (Tribal). ...	4=1	Original completed, corrected, and revised to date from recent fresh surveys, and published with the names of the various Naga Tribes therein located.
City and Cantonment Plans.	Ft. Inch.	
Datia, City and Environs ...	500=1	Drawn on a blue print of the original for a new edition.
Jocobabad, City and Cantonment ...	600=1	Re-drawn to scale from various materials to date for a new edition.
District Maps.	Miles. Inch.	
Bijnor District ...	8=1	Drawn for the Gazetteer, North-West Provinces.
Budaun do. ...	8=1	
Purneah do. ...	4=1	Extracted from the Atlas of India, and prepared and completed for publication to date.
Rungpore do. ...	4=1	
Balaghat do. ...	4=1	Compilation in progress (from recent surveys) of new maps of these districts.
Karnal do. ...	4=1	
Mhairwara, 4 sheets ...	1=1	Forest tracts inserted in 9 copies of each of these districts for the Commissioner, Ajmere.
Ajmere, 6 sheets ...	1=1	
Index Maps.		
Index to the sheets of the Atlas of India	256=1	5 copies showing engraving and publication to date prepared for office use.
Do. do. do. ...	64=1	2 copies prepared for office use on India map No. 3.
Index to the Great Trigonometrical Survey.	96=1	4 copies showing the various published sheets, and the seasons of survey of the several series of triangulation, prepared for office use.
Index to the sheets of the		
Gwalior and Central India Survey ...	32 miles=1 inch.	Revised to illustrate the publication of the several sheets and progress of the several surveys named, and to accompany the Administration Report for season 1877-78.
Khandesh and Bombay Native States Survey.		
North-Eastern Division, Central Provinces Survey.		
Central Provinces and Vizagapatam Agency Survey ...		
Bhopal and Malwa Survey ...		
Khasi, Garo, and Naga Hills Survey ...		
Rajputana Survey ...		
Mysore Survey ...		

Sheets of the Atlas of India, 4 miles = 1 inch.

Sheet 12, N. E., S. E.	Parts of Cutch and Kattywar.	Drawing in outline, completed. Hills drawn on a dry print proof.
„ 13, N. E.*	Part of Kattywar ...	Drawing in outline, in progress.
„ 22, N.W.,* S. W., S. E.,	Part of Guzerat, Bombay Presidency.	Drawn complete with hills. Do. do. Drawing in outline, completed.
„ 23, N. E.*, N. W.,	Part of Guzerat, Bombay Presidency.	Do. do. to date. Hills drawn on a dry print proof.
„ 18, S. W., S. E.*, N. W., N. E.*	Part of Bahawalpore.	Drawn complete to meridian of 71°. Additions on west in progress. Drawn complete for engraving.
„ 33, N. E., N. W.*, S. W.,	Parts of Ajmere and Joypore.	Addition on west, drawn complete with hills. Drawing in outline, completed to date. Drawn complete with hills to, date.
„ 35, N. E., S. E.,	Parts of Jhallawar, Neemuch, Oodeypore, &c.	Hills drawn on a dry print proof. Drawing in outline completed to date.
„ 37, N. E., S. E.,	Parts of Khandesh and Native States in Central India.	Hills drawn on a dry print proof. Drawing in outline, completed to date.
„ 48. N. E.,*	Parts of Bijnor, Dehra Dun, &c.	Do. in progress.
„ 53, S. W.,	Parts of Indore and Bhopal.	Drawing in outline completed. Hills in progress.
„ 54, full plate.	Parts of Berar and Nimar.	Additions on west drawn with hills, complete to date, of recent surveys.
„ 65, „ *	Parts of Bijnor, Kumaon and Garhwal.	Drawing in outline completed to date. Part of Bijnor added in outline on a dry print, to complete.
„ 66, S. W.,		
„ 73, full plate.	Parts of Chanda and Berar.	Portion of Ahiri Zemindaree on south-east, compiled and drawn complete with hills.
„ 86, S. E.,*	Parts of Oudh and Nepal...	Compiled and drawn complete with hills.
„ 90, S. W.,	Parts of Mandla, Raipur, Chanda, Balaghat, and Bastar; Central Provinces.	Hills drawn on a dry print proof.
„ 91, N. W.,		Do. do.
„ 92, N. W., S. W.,		Hills drawing, in progress. Hills drawn on a dry print proof.
„ 93, N. W.,		Do. do.
„ 95, N. E.,*	Part of Masulipatam ...	Compiled and drawn, complete.
„ 129, N. E.,* S. E.,*	Parts of Lakimpur and Sibsagar, Assam.	Drawing in outline, completed to date.
„ S. W.,*		Do. in progress.
„ 130, N. E.,* S. E.,*	Parts of Sibsagar and Naga Hills, Assam.	Do. completed to date. Do. do. Drawn complete, with hills, to date.
„ 131, N. E.,* S. W.,	Parts of Mainpur, Cachar, and Naga Hills, Assam.	Do. do. Additions on east, completed with hills to date.

Standard Sheets of the Topographical Survey re-drawn for Photozincography.

Maps, &c.	Scale.	Remarks and Progress.
Central Provinces and Vizagapatam Agency Survey.	Miles. Inch.	
Sheets 11,15,33 and 31	1 = 1	Fair drawn from the original field sheets.
„ 12,13,14	1 = 1	Drawing in progress, in various stages.
„ 32,34,35 in one	2 = 1	Fair drawn from the original field sheets.
„ 30 and 97 in one, 25 and 37 in one ...	2 = 1	Drawing in progress, in various stages.
Ganjam and Orissa Survey.		
Sheets, 62,63,64,65,66 and 67 ...	1 = 1	Fair drawn from the original field sheets.
„ 88,89,90,91 in one	2 = 1	Drawing in progress, in various stages.
„ 92,93,94,95, & 95a in one		
Khasi, Garo, and Naga Hills Surveys.		
Sheets 111,122,125,126,129 and 130 ...	2 = 1	Fair drawn from the original field sheets.
Mysore Survey.		
Sheet 38	1 = 1	Outline and names drawn.
Rewah Survey.		
Sheets 7,8,34,36 and 37	1 = 1	Originals examined, touched up and completed for a second edition.
Rajputana Survey.		
Sheet 17	1 = 1	Originals examined, touched up and completed for a second edition.

The 37 sheets marked * are new sheets.

Miscellaneous Maps, Tracings, &c.

	Miles. Inch.	
Routes by land and water between Tavoy, Tenasserim and Bancock.	8 = 1	Six copies prepared for the Foreign Department on Bagge's map of Tenasserim.
Trade Routes in Ladakh—Map to accompany a memorandum on—	...	Fair copy made with comparative Tables of Distances in Vertical Section for the Foreign Department.
Portion of Bengal showing the Railways in the North-Eastern System.	32 = 1	Extracted from the 32-mile map of India for the Director of State Railways, North-Eastern System.
Assam Hill Districts and Punjab Native States.	...	Areas of the Hill Districts in Assam and of the ative States attached to the Punjab, extracted for the Chief Commissioner and the Punjab Government.
Parts of Districts Amraoti, Ellichpur and Akola, Berar.	1 = 1	Tracings made on vellum cloth from the 1-inch sheets for the Forest Department.
Holkar and Neemuch State Railway ...	32 = 1	An extract from the 32-mile map of India, on which this line was inserted with reference notes for the Director, Holkar and Neemuch State Railway.
Central India	8 = 1	Trace of a portion from the original made for the Political Agent, Gwalior.
Central India Agency, Rajputana Agency	16=1	Two silver prints of the office compilations mounted and blanks completed with additions, from the best available sources, for His Excellency the Viceroy.
India sketch map, 6 sheets ...	32=1	Showing the several railways and telegraph lines to date. Two copies prepared in colours, with reference notes complete; one for His Excellency the Viceroy, the other for office use.
Rangoon Town, block plans in 35 sheets	1=50	The blocks in the original sheets numbered agreeably to the key map furnished by the Surveyor, and all the sheets completed with headings, foot-notes, scale, &c., for reproduction.
Boundary between Mandi, Kulu and Suket.	4=1	Trace on vellum cloth made for the Deputy Commissioner, Kangra.
Average heights for every degree of India	...	112 heights below latitude 24° extracted. In progress.
Chart of triangulation, Ganjam and Orissa Survey, seasons 1868 to 1872.	...	Extracts on vellum cloth made from the same, and a synopsis of latitudes, longitudes, azimuths and heights, with descriptions of 28 principal stations, prepared for the Superintendent, Revenue Surveys, Madras.

Examination, corrections and additions, to original Survey sheets, maps, &c.	36 original sheets examined, corrected and touched up, for reproduction and engraving.
Examination, corrections and additions to engraved, lithographed, and photozincographed proofs, various.	Blanks filled up; railways, boundaries, territorial names, headings, foot-notes, titles, &c., inserted, examined, completed, and corrected in 330 sheets.

Atlas sheets and engraved maps coloured, 4,851 sheets.
Lithographed and photozincographed maps and plans coloured; 21,498 sheets.

In the Examining Branch, since its formation, the following work has been done:—

Hill shading	...	4 full quarter sheets of hills.
Examination	...	5 quarter sheets hill drawing.
,,	...	17 ,, outline and writing.
,,	...	10 ,, projections.
,,	...	5 sheets original compilations.
,,	...	6 ,, projections.
,,	...	62 ,, proofs of engravings.
,,	...	2 special maps.
,,	...	101 sheets miscellaneous maps.

EDWARD H. STEEL, *Captain,*
Assistant Surveyor General,
in charge Drawing Branch.

SURVEYOR GENERAL'S OFFICE;
CALCUTTA,
The 1st July 1879.

*Progress Report of the Engraving Branch from the 1st January to the 30th September 1878.**

	GENERAL COMPILATIONS.
Map of India, in 6 sheets; scale 32 miles = 1 inch—	
Sheet 1	Outline, writing and corrections up to date; as far as drawing, finished.
„ 4	Ditto ditto ditto.
„ 5	Outline ¾ finished. In progress.
Map of India, 80 miles = 1 inch—	
Sheet 1	Outline finished; well advanced as far as first order.
„ 2	Outline and writing done as far as first order.
Map of India, 256 miles = 1 inch—	Outline, finished.
„ „ „ ...	The hills to the old plate have been all repaired, and some slight additions done.
Map of Bengal, 16 miles = 1 inch—	
Sheet 1	Corrections completed, and writing as far as second orders, just commenced. In progress.
„ 2	About the same as Sheet 1.
Map of the Punjab, 16 miles = 1 inch, in 4 sheets	Borders cut and the four plates projected. Waiting orders.
Map of Rajputana, in 2 sheets—	
Sheet 1	Outline completed.
„ 2	Outline completed as far as drawing. Very small portion on this sheet.

INDIAN ATLAS SHEETS.

NOTE.—The progress during the year is shown in square inches. A full sheet of the Atlas contains 927·2 square inches; quarter plate 231·8 square inches.

Number.	Outline and writing.	Hills. Sand.	New sheets completed and published.	
	Sq. in.	Sq. in.		
23 N. W. ...	...	30	Full sheet. ...	Transferred.
34 N. W. ...	...	80	Ditto. ...	Ditto.
34 S. W. ...	...	90	Ditto. ...	Ditto.
52 S. W. ...	...	131	Ditto. ...	Ditto.
95 N. W. ...	53	...	Finished sheet. ...	Ditto.
95 N. E. ...	10	...	Ditto. ...	Ditto.
124 N. E. ...	...	35	Ditto. ...	Ditto.
124 N. W. ...	...	20	Ditto. ...	Not transferred.
125 N. W. ...	...	25	Full sheet. ...	Ditto.
130 N. W. ...	...	60	Ditto. ...	Transferred.
130 S. W. ...	...	145	Ditto. ...	Not transferred.
	63	616		
			New Sheets in hand.	
12 N. E. ...	71	...	Outline, writing and jungle done as far as drawing. Plate put down. Waiting orders.	
12 S. E. ...	100	...	Outline, ¾ finished to date. Writing half done. In progress.	
18 N. E. ...	150	...	Outline, ¾ the plate finished. Writing nearly completed. In progress.	
18 N. W. ...	136	...	Outline, up to margin, done. Writing just commenced. In progress.	
		Sand.		
18 S. W. ...	97	27	About ¼ survey, outline and writing done. Sand-hills just commenced. In progress.	
		Sand.		
18 S. E. ...	20	20	Small portion of survey outline, writing, and sand-hills done. Jungle will be put in hand as soon as possible.	
22 N. W. ...	120	...	Outline, finished as far as drawing. Writing, nearly done. In progress.	
22 S. W. ...	170	...	Outline, done. Writing nearly finished as far as drawing. In progress.	
22 S. E. ...	102	...	Outline and writing, finished as far as drawing. Jungle in progress.	
23 N. E. ...	21	...	Border, projections, outside names and figures, done. Outline, ¼ of the plate. In progress.	
33 N. W. ...	132	...	Outline and writing, done as far as drawing. Sand-hills ¼ done. In progress.	
33 S. W. ...	83	...	Outline, done. Writing, ¼ finished. In progress.	
35 N. E. ...	216	...	Writing, nearly finished. In progress.	
	1,418	47		

* The returns from 1st October to 31st December 1877 were included in the Surveyor-General's Report for 1876-77.

Number.	Outline and writing.	Hills, sand.	New Sheets in hand.
	Sq. In.	Sq. In.	
35 S. E. ...	136	73	Writing, as far as drawing, done. Hills well advanced. In progress.
36 N. E. ...	18	...	Small portion of survey. Outline and writing, done. Plate put down. Waiting orders.
36 S. E. ...	124	...	Writing done as far as drawing. Corrections in progress.
37 N. E. ...	71	...	Writing as far as drawing, done. Hills just commenced. In progress.
37 S. E. ...	52	...	Small portion of survey. Outline and writing, done, Plate put down. Waiting orders.
53 S. W. ...	55	...	Outline up to margin, done. Writing in progress.
66 N. W. ...	18	...	Outline, as far as drawing, ¾ done. In progress.
66 N. E. ...	60	...	Outline, as far as drawing, completed. Correction to ditto. In progress.
66 S. W. ...	22	...	Outline, as far as drawing, ¾ done. In progress.
66 S. E. ...	21	...	*Do.* do. nearly completed. In progress.
86 S. E. ...	44	7	Outline, up to margin, and writing, done. Hills, ¼ completed. In progress.
90 S. W. ...	...	153	Hills, about ¾ done. In progress.
91 N. W. ...	89	...	Outline, ¼ done. Writing, about ¼ completed. In progress.
91 S. W. ...	200	...	Outline, up to margin, done. Writing, about ¼ done. In progress.
92 N. W. ...	39	...	Outline, up to margin, done and under examination. The writing will be commenced at once.
92 S. W. ...	104	50	Writing, up to margin, finished. Hills, about ¼ done, and in progress.
93 N. W. ...	200	65	Outline and writing, up to margin, finished. Hills, just commenced.
129 S. W. ...	...	...	Border, projections, outside names and figures, done; tracing, just commenced, and in progress.
130 N. E. ...	...	...	Borders, projections, and outside names, completed.
130 S. E. ...	...	...	Plate finished as far as orders. Put down.
131 N. E. ...	...	...	Border, projections, and outline, finished. Outside names and figures, in progress.
32 S. E. ...	9	60	Small portion of fresh survey. Outline and writing done. Heavy additions to sand-hills, ¼ done and in progress.
33 N. E. ...	80	20	Small portion of fresh survey. Outline and writing, done. Sand-hills, ¼ done and in progress.
53 S. E. ...	...	26	Outline, writing, and hills to new portion of fresh survey, completed.
72 N. E. ...	50	...	Heavy portion of new survey. Outline, done. Writing well advanced and in progress.
72 S. E. ...	2	...	Slight alterations and additions, completed.
87 N. E. ...	...	...	*Do.* do. do.
131 S. W. ...	...	31	Hills in progress, of new survey: Plate again put down for more urgent work.
	2,812	562	

Old full Atlas Sheets.

No.	Outline and writing.	Hills, Sand.	Heavy additions, corrections and repairs.
	Sq. In.	Sq. In.	
41	...	...	Outline repaired. Writing being re-cut; in progress and nearly done. Heavy sheet.
47	...	...	Slight additions, done. Repairing, writing, ¾ done and in progress.
54	59	...	Heavy additions of new survey and to the hill work. Outline, done. Writing just commenced, and in progress.
56	...	...	Writing repaired, completed.
58	...	...	*Do.* do.
59	...	...	Heavy sheet of hills. Hill work repaired, completed.
60	...	...	Writing, not all repaired. Hill of old work, repaired. Plate put down for more urgent work.
62	...	...	Writing repaired, completed.
63	...	...	*Do.* do.
65	36	...	New portion of fresh survey. Outline, done. Writing, nearly finished.
73	...	...	Repairing the hill work. Just commenced.
74	...	20	New hills engraved, finished. The hills of old portions have been repaired. Heavy sheet.
78	...	...	Repairing, writing, well advanced. Plate put down for more urgent work.
102	...	...	*Do.* do. do. do.
113	...	...	Hill work and jungle, finished.
114	...	...	Repairing, writing, heavy sheet, finished.
115	...	...	*Do.* do. nearly finished. In progress.
118	...	...	Slight additions to Railway, and corrections done.
121	...	...	Jungle, &c., finished.
	95	20	

The following atlas sheets have been projected, borders cut, and outside names and figures in progress:

All four quarters of 48, 66, 129 and 138: the borders and projections are finished. Outside names and figures in progress.

Number of plates in hand during the nine months, 1878 ... 119.

The following sheets are being engraved in England :—

Nos. 28, 44*a* S. E., 45 N. E., 45 S. E., 63*a* N. W., 63*a* S. W., 64 N. W., 70 S. W., 71 N. E., 71 S. E., 71 S. W., 90 N. W., 90 N. E., 90 S. E., 91 N. E., 128 N. E.

MISCELLANEOUS MAPS, &c.

Map of the Himalaya routes ; scale, 32 miles=1 inch ...	Border and projections, done. Outline, nearly finished.
Acre, Comb scale ; 16 inches=1 mile ...	Engraved and finished.
Do. do. 32 do. ...	Do. do.
Scale, 80 chains=4 inches ...	Do. do.
Chart of Colombo Harbour ...	A very heavy sheet. Outline, writing and figures, and tint, completed. For the Marine Survey Department.
Three plates of Kater's convertible pendulum ...	All three plates engraved and finished.
Index chart to the Great Trigonometrical Survey of India ...	Outline, nearly repaired. Small additions and writing, well advanced. Repairing, in progress.
New plate of office note heading ...	Engraved and finished.
Two plates of specimen of symbols for the Atlas Sheets	Do. do.
New plate of imprints ...	Do. do.
Alterations of dates to imprints ...	Do. do.

COPPER-PLATE PRINTING.

Proofs	1,552
Transfers	481
Impressions	5,185
TOTAL ...	7,218

C. W. COARD,
Superintendent, Engraving Branch.

EDWARD H. STEEL, *Captain,*
Assistant Surveyor General,
in charge Engraving Branch.

SURVEYOR GENERAL'S OFFICE;
CALCUTTA,
The 1st January 1879.

APPENDIX.

Extract from the Report of CAPTAIN R. V. RIDDELL, R.E., *in charge of the Lithographic Branch, Surveyor-General's Office, for the year ending 30th September 1878.*

2. Twenty-five sheets of Revenue Survey maps (double royal size) have been drawn on transfer paper and transferred to stone.

3. Statement A shews the detail of the departmental lithographic work completed during the year, amounting in value to Rs. 26,790 very nearly.

4. Statement B shews the amount and value of work done for other Departments; the number of subjects treated, amounts to $\frac{7}{16}$th, or nearly half of those prepared for the Survey Department; but the number of impressions, or the lithographic press work, is nearly half more than that of the regular departmental work, as represented by 126,901 pulls for other Departments, against 78,062 for the regular work. The value of the work done for other Departments is Rs. 16,172.

5. Statement C shews the abstract of the whole work completed during the year, as well as the outlay in salaries and contingent charges actually spent.

6. The most important work done during the year has been the completion of the Geological Map of India, in 4 sheets, on the scale of 1 inch = 64 miles.

7. Four extra lithographic draftsmen have been engaged, as sanctioned by Government letter No. 201, dated 26th April last, with a view of increasing the hill-drawing power of the office, and these draftsmen have already made rapid progress.

A.

Statement of departmental work done by the Lithographic Branch, Surveyor-General's Office, between the 1st October 1877 and 30th September 1878, for the Survey Department.

Description of Maps.		Scale of Maps.	Size of each Sheet.	No. of Sheets.	No. of coloured Copies.	No. of uncoloured Copies.	Total No. of Copies.	Value.	Remarks.
New maps, &c., drawn and printed during the year.								Rs. A. P.	
GENERAL MAPS.									
Map of Assam, in 6 sheets, sheet No. 1.	.....	1 inch=8 miles	Imperial ...	1	155	50	205	611 13 6	
Map of Assam, in 6 sheets, sheets Nos. 2 and 4.	.....	Ditto ...	Ditto ...	2	...	...	...	.....	Not yet printed.
INDEX MAPS.									
Index to the sheets of District Beerbhoom.	Corrections and additions drawn.	.....	½ sheet, double royal.	1	...	300	300	34 6 3	
Index to the sheets of District Rungpore.	Ditto ...	.....	Ditto ...	1	...	282	282	66 6 3	
REVENUE SURVEY MAPS.									
District Dinagepore, in 13 sheets, sheet No. 6.	.....	1 inch=1 mile	Doubleroyal	1	...	282	282	501 6 0	
District Dinagepore, in 13 sheets, sheets Nos. 7, 10 and 12.	.....	Ditto ...	Ditto ...	3	...	...	...	.....	Not yet printed.
District Rungpore, in 13 sheets, sheets Nos. 9 and 11.	.....	Ditto ...	Ditto ...	2	...	564	564	1,088 7 6	
District Rajshahye, in 11 sheets, sheets No. 1, 2, 3, 4, 6 and 7.	.....	Ditto ...	Ditto ...	6	...	...	...	.....	Not yet printed.
District Furreedpore, in 13 sheets, sheets Nos. 1, 2, 3, 4, 5, 6, 7, 8 9, 10, 11, 12 and 13.	.....	Ditto ...	Ditto ...	13	...	...	...	.....	Ditto.
PLANS.									
Plan of the Town and Cantonment of Jacobabad.	.....	1 inch=10 chains.	Ditto ...	1	...	...	...	.....	
Carried over ...	.....	.....	.....	31	155	1,478	1,633	2,302 7 6	

Description of Maps.	Scale of Maps.	Size of each Sheet.	No. of Sheets.	No. of coloured Copies.	No. of uncoloured Copies.	Total No. of Copies.	Value.	Remarks.
							Rs. A. P.	
Brought forward ...	.....	.....	31	955	1,478	2,433	2,302 7 6	
Maps transferred from engraved sheets of Atlas of India and from standard stones.								
GENERAL MAPS.								
Map of Indian Atlas, quarter sheet, No. 23, S. W.	Colour stone prepared.	1 inch = 4 miles	¼ sheet atlas	1	203	202	310	98 7 1
Map of Indian Atlas, quarter sheet, No. 23, N. W.	Ditto ...	Ditto ...	Ditto ...	1	155	50	205	59 6 4
Map of Indian Atlas, quarter sheet, No. 35, N. E.	Ditto ...	Ditto ...	Ditto ...	1	35	15	50	22 6 1
Map of Indian Atlas, quarter sheet, No. 52, S. W.	Ditto ...	Ditto ...	Ditto ...	1	267	103	369	107 3 10
Map of Indian Atlas, quarter sheet, No. 72, S. W.	Corrections and colour stone prepared.	Ditto ...	Ditto ...	1	151	50	201	60 2 4
Map of Indian Atlas, quarter sheet, No. 90, S. W.	Ditto ...	Ditto ...	Ditto ...	1	36	15	51	33 6 6
Map of Indian Atlas, quarter sheet, No. 93, S. W.	Colour stone prepared.	Ditto ...	Ditto ...	1	302	100	302	77 6 6
Map of Indian Atlas, quarter sheet, No. 93, N. W.	Corrections and colour stone prepared.	Ditto ...	Ditto ...	1	39	15	53	21 2 1
Map of Indian Atlas, quarter sheet, No. 95, N. W.	Colour stone prepared.	Ditto ...	Ditto ...	1	158	50	208	61 12 4
Map of Indian Atlas, quarter sheet, No. 105, S. W.	Ditto ...	Ditto ...	Ditto ...	1	208	102	310	63 11 4
Map of Indian Atlas, quarter sheet, No. 130, N. W.	Corrections and colour stone prepared.	Ditto ...	Ditto ...	1	155	50	205	61 15 4
Map of Indian Atlas, full sheet, Nos. 48 and 103.	.....	Ditto ...	Antiquarian	2	...	60	60	3¾ 4 2
Map of Province of Sindh ...	Colour stone prepared.	1 inch = 16 miles	Double elephant.	1	211	103	314	201 12 2
Map of India, illustrative of the pendulum operations of the Great Trigonometrical Survey of India during the years 1865 to 1872.	Chalk hills; alterations, corrections and additions drawn.	1 inch = 128 miles	Imperial ...	1	...	...	...	..... Not yet printed.
DISTRICT MAPS.								
District Partabgarh. ...	Corrections, boundaries, &c., drawn and colour stone prepared.	1 inch = 4 miles	Super royal	1	152	50	202	118 5 6
Do. Hardoi.	Ditto ...	Ditto ...	Ditto ...	1	156	50	206	127 12 9
Do. Sitapur	Ditto ...	Ditto ...	Ditto ...	1	156	50	206	132 5 6
Do. Kheri.	Ditto ...	Ditto ...	Ditto ...	1	155	50	205	132 15 6
Do. Gonda	Ditto ...	Ditto ...	Atlas ...	1	150	50	200	106 2 6
Do. Sultanpur	Ditto ...	Ditto ...	Super royal	1	214	100	314	192 5 8
Maps, &c., transferred previously from the engraved sheets, but printed during the present year.								
GENERAL MAPS.								
Map of Indian Atlas, quarter sheet, No. 23, N. W.	.....	1 inch = 4 miles	¼ sheet atlas	1	104	52	156	45 12 9
Map of Indian Atlas, quarter sheet, No. 34, N. W.	.....	Ditto ...	Ditto ...	1	206	100	306	74 4 4
DISTRICT MAPS.								
District Moradabad ...	Colour stone prepared.	1 inch = 4 miles	Atlas ...	1	200	105	305	231 12 3
Do. Darbhunga ...	Ditto ...	Ditto ...	Ditto ...	1	205	100	305	183 5 0
Do. Unao ...	Ditto ...	Ditto ...	Imperial ...	1	152	53	205	72 3 6
Do. Fyzabad ...	Ditto ...	Ditto ...	Super royal	1	205	100	305	192 2 10
Maps, &c., drawn previously, but printed during the present year.								
REVENUE SURVEY MAPS.								
District Beerbhoom, in 7 sheets, sheet No. 4.	.....	1 inch = 1 mile	Double royal.	1	...	312	312	1,000 10 3
District Dinagepore, in 12 sheets, sheets Nos. 3, 4, 5, 8 and 11.	.....	Ditto ...	Ditto ...	5	...	1,670	1,670	2,349 1 0
District Rungpore, in 13 sheets, sheets Nos. 1, 2, 3, 4, 5, 6, 7, 8, 10, 12 and 13.	.....	Ditto ...	Ditto ...	11	...	3,252	3,252	3,927 8 5
District Sonthal Pergunnahs, in 16 sheets, sheet No. 12.	.....	Ditto ...	Ditto ...	1	...	312	312	556 14 3
PLANS.								
Plan of Calcutta	.....	6 inches = 1 mile	Double elephant.	2	...	100	100	1,201 10 8
Plan of City of Oudh or Ajoodhia, District Fyzabad.	.....	10 inches = 1 mile	Ditto ...	1	...	212	212	237 4 6
Carried over ...	.....	.....	.....	79	4,035	8,810	12,845	15,409 10 3

Description of Maps.		Scale of Maps.	Size of each Sheet.	No. of Sheets.	No. of coloured Copies.	No. of uncoloured Copies.	Total No. of Copies.	Value.	Remarks.
								Rs. A. P.	
Brought forward ...	.....	.....	.....	79	4,036	8,810	12,946	46,409 10 3	
Reprints.									
GENERAL MAPS.									
Preliminary Map of Bhootan ...	Corrections and additions drawn.	6 inch = 8 miles	Double elephant.	1	...	100	100	314 1 8	
Map of India, No. 2, showing the progress of the Imperial Surveys to 1st October 1877.	Corrections and colour stone prepared.	1 inch = 128 miles	Imperial ...	1	375	...	375	183 2 4	
Map of Central Provinces, in 4 sheets.	.....	1 inch = 16 miles	Atlas ...	4	...	80	80	42 2 9	
Map of India, No. 1 ...	Colour stone prepared.	1 inch = 256 miles	Foolscap ...	1	200	...	200	82 10 0	
Ditto, No. 1C ...	.....	Ditto ...	Ditto ...	1	...	500	500	26 4 10	
Map of Baluchistan, in 7 sheets	Chalk hills of one section re-drawn.	1 inch = 16 miles	Double elephant.	2	...	120	120	239 5 0	
Map of India, No. 2D ...	.....	1 inch = 128 miles	Imperial ...	1	...	200	200	23 12 3	
Map of North-Western Provinces and Oudh, in 4 sheets.	.....	1 inch = 16 miles	Ditto ...	1	...	100	100	79 9 0	
Map of Central Provinces' ...	.....	1 inch = 32 miles	Atlas ...	1	...	40	40	9 9 0	
Map of Afghanistan, in 2 sheets	.....	1 inch = 16 miles	Antiquarian	2	...	102	102	684 10 2	
Punjab compilation map, in 9 sheets, sheet No. 2.	.....	1 inch = 8 miles	Ditto ...	1	...	302	302	55 7 6	
Sketch Map of India, in 6 sheets	.....	1 inch = 32 miles	Double royal	6	...	92	92	178 10 6	
Map of Assam, in 9 sheets, sheet No. 3.	.....	1 inch = 8 miles	Imperial ...	1	...	203	203	17 11 9	
DIVISIONAL MAPS.									
Map of Chittagong Division ...	.....	1 inch = 8 miles	Atlas ...	1	...	120	120	24 3 6	
DISTRICT MAPS.									
District, Darjeeling	.....	1 inch = 4 miles	Atlas ...	1	...	60	60	24 6 1	
INDEX MAPS.									
Index to the sheets of Gwalior and Central India Topographical Survey, No. 1 Party.	Corrections and colour stone prepared.	.....	½ sheet super royal.	1	402	50	452	60 2 9	
Index to the sheets of the Khandesh and Bombay Native States Survey, No. 2 Party.	Ditto ...	.....	Foolscap ...	1	402	50	452	62 3 9	
Index to the sheets of Ganjam and Orissa Topographical Survey, No. 3 Party.	Ditto ...	.....	½ sheet double royal.	1	402	50	452	62 3 9	
Index to the sheets of North-East Districts, Central Provinces, Topographical Survey, No. 4 Party.	Ditto ...	.....	Foolscap ...	1	402	50	452	62 12 9	
Index to the sheets of Bhopal and Malwah Topographical Survey, No. 5 Party.	Ditto ...	.....	Ditto ...	1	402	50	452	60 7 9	
Index to the sheets of Garo, Khasi and Naga Hills Topographical Survey, No. 6 Party.	Ditto ...	.....	½ sheet double royal.	1	402	50	452	61 1 9	
Index to the sheets of Rajputana Topographical Survey, No. 7 Party.	Ditto ...	.....	Ditto ...	1	402	50	452	60 7 9	
Index to the sheets of the Indian Atlas shewing the state of the engraving to 1st October 1877.	Colour stone prepared.	.....	Foolscap ...	1	402	50	452	101 1 0	
Index to the sheets of the Atlas of India.	Ditto ...	.....	Imperial ...	1	...	21	21	7 4 7	
REVENUE SURVEY MAPS.									
Map of Oudh Revenue Survey, in 33 sheets, sheet No. 10.	Additions and corrections.	1 inch = 1 mile	Double elephant.	1	...	312	312	96 6 8	
Map of Oudh Revenue Survey, in 33 sheets, sheets Nos. 41 and 42.	Ditto ...	Ditto ...	½ sheet do.	4	...	624	624	242 0 4	
PLANS.									
Plan of Calcutta	Corrections and additions.	6 inches = 1 mile	Double elephant.	2	...	308	308	239 14 0	
Cadastral Maps	.....	.....	Imperial ...	225	...	11,525	11,525	3,464 9 10	
Forms	.....	.....	Various sizes	42	...	16,359	16,359	1,234 10 9	
Miscellaneous Drawings ...	.....	.....	Ditto ...	38	...	11,502	11,502	3,250 9 0	
TOTAL, ...	.....	.....	.....	126	8,229	51,009	59,508	26,790 6 6	

B.

Work done for other Departments.

For what Departments.	Number of Maps.	Number of Sheets.	Number of Sheets coloured.	Number of Sheets uncoloured.	Number of Copies.	Number of Impressions	Value. Rs.	A.	P.
Home Department	12	12	None	12	1,578	1,578	278	1	7
Foreign Department	8	10	3	7	525	1,410	1,511	8	7
Military Department	36	36	1	35	1,373	1,195	976	11	8
Department of Revenue, Agriculture, and Commerce	5	5	1	4	210	274	189	3	0
Telegraph Department	11	11	None	11	3,824	2,822	525	7	0
Bengal Office	13	13	1	12	3,093	4,013	523	5	10
Marine Survey Department ...	1	1	1	None	165	465	129	3	4
Sanitary Commissioner	7	7	2	5	3,286	4,114	457	8	10
Quarter Master General	8	8	None	8	2,311	2,311	277	9	5
Meteorological Reporter to the Government of India	8	8	3	5	3,372	6,492	723	4	6
Archæological Survey of India ...	46	46	None	46	34,642	10,865	1,371	2	2
Geological Survey Office	2	3	3	None	2,965	33,795	3,357	5	4
Miscellaneous Drawings	73	76	35	41	45,681	57,567	5,357	9	0
Total ...	230	236	50	186	1,03,015	1,26,901	16,172	0	3
Total of Departmental Work from Statement A	...	426	...	...	59,898	78,062	26,790	6	6
Grand Total ...	...	662	...	...	1,62,913	2,04,963	42,962	6	9

C.

Abstract of Drawings and Printing executed at the Surveyor-General's Office, Lithographic Branch, from 1st October 1877 to 30th September 1878.

Subject.	Number of Sheets.	Number of Copies.	Number of Impressions.	Value. Rs.	A.	P.
District and General Maps, &c.	53	8,514	14,575	5,241	3	5
Index Maps	11	4,222	8,242	638	13	7
Revenue Survey Sheets Maps; scale 1 inch = 1 mile ...	26	7,128	8,064	10,692	10	9
Plans	5	618	1,832	2,238	13	2
Cadastral Maps	225	11,525	11,525	3,464	9	10
Miscellaneous Drawings	38	11,502	14,459	3,259	9	0
Forms	42	16,389	19,365	1,254	10	9
Maps drawn but not printed	400	59,898	78,062	26,790	6	6
	26	...	...	...		
Total ...	426	59,898	78,062	26,790	6	6
Work done for other Departments.						
Miscellaneous Maps	50	13,495	22,527	5,136	10	3
Do. Plans and Sketches, &c.	171	86,555	70,579	7,378	0	6
Geological Maps	3	2,65	33,795	3,357	5	6
	224	1,03,015	1,26,901	16,172	0	3
Maps drawn but not printed	12	...	...	...		
	236	1,03,015	1,26,901	16,172	0	3
Total of Printing in Lithographic Branch	662	1,62,913	2,04,963	42,962	6	9
Type Branch.						
Departmental Orders	24	2,801	2,981	84	0	0
Memorandum and Forms for use of the Departments	364	1,47,297	2,21,988	5,892	0	0
Forms for Topographical and Revenue Surveys	49	57,158	1,43,388	2,292	0	0
Transfers of headings, foot-notes, references to published maps ...	1,564	16,233	16,233	326	0	0
Total ...	2,002	2,23,489	3,94,690	51,556	6	9
			Total Value ...	51,556	6	9

Statement of Expenditure of the Lithographic Branch, Surveyor-General's Office, from 1st October 1877 to 30th September 1878.

	Rs.	A.	P.
Permanent Establishment	35,668	15	4
Contingent Charges	4,487	7	6
TOTAL ...	40,156	7	10

R. V. RIDDELL, *Captain, R. E.,*
Assistant Surveyor-General,
In charge Lithographic Branch.

SURVEYOR-GENERAL'S OFFICE,
LITHOGRAPHIC BRANCH;
Calcutta, 7th January 1879.

Extract from the Progress Report, No. $\frac{445}{F}$, dated 27th December 1878, by CAPTAIN J. WATERHOUSE S.C., *Assistant Surveyor-General, in charge, on the working of the Photographic Branch during the year, 1st October 1877 to 30th September 1878.*

Amount of work.

2. The amount of work performed during the year under report, as compared with the previous year, is shown in the following table :—

	Ordinary Work.				Cadastral Maps, North-Western Provinces.			
	1st October 1876 to 30th September 1877.	1st October 1877 to 30th September 1878.	Difference.	Difference in square feet.	1st October 1876 to 30th September 1877.	1st October 1877 to 30th September 1878.	Difference.	Difference in square feet.
Originals	1,244	1,436	+192	...	2,009	3,016	+1,007	.....
Negatives ...	1,565	1,193	−372	...	4,334	3,376	−956	.....
	3,046·76 sq. ft.	3,568·18 sq. ft.	...	+521·42	11,241·44 sq. ft.	23,315·06 sq. ft.	.....	+12,104·22
Photo-transfer	1,663	1,139	−524	...	5,350	3,421	−929	.....
	3,708·64 sq. ft.	3,900·01 sq. ft.	...	+351·37	11,646·41 sq. ft.	26,579·87 sq. ft.	.....	+14,933·46
Silver prints	871	837	−34	...	.....	.....	.....	.....
	1,361·22 sq. ft.	2,037·29 sq. ft.	...	+676·07	.....	.....	.....	.....
Transfers to zinc ...	672	1,368	+696	...	2,021	3,281	+1,260	.....
Number of pulls ...	144,184	150,302	+6,118	...	97,000	89,000	−8,000	.....
Number of sheets ...	149,665	207,329	+57,664	...	97,000	89,000	−8,000	.....
Number of copies ...	133,318	169,390	+36,072	...	65,000	53,375	−12,625	.....

Progress.

3. On the whole, the work of the office during the year shows a considerable increase over the previous year, the total printed out-turn being 296,329 impressions against 245,665 of last year. The number of original subjects received for reproduction as the ordinary work of the office was considerably larger, and though the number of negatives, photo-transfers, and silver prints, is less than last year, their superficial area is greater. The zinc printing on account of the office shows an increase under all heads, due in great measure to the additional work on account of the Bengal Cadastral Surveys. The out-turn of maps of the Cadastral Surveys of the North-Western Provinces shows a large increase, about one-third more sheets having been reproduced than were done last year. Here, again, negatives and photo-transfers show a decrease in number, though the superficial area is very much greater. This is due to the use of large negatives. There is a correspondingly large increase in the number of sheets printed off zinc, though the number of pulls and copies shows a diminution in consequence of the number of copies of each sheet being reduced from 50 to 25. A large proportion of the work turned out during the year has been for other departments, the details of which will be found in the attached statement.

4. The approximate expense of working the office during the financial year 1877-78 is shown, as far as materials are available, in the following table :—

Office.	Rs. A. P.	Rs. A. P.
Superintendent's salary from 1st April 1877 to 31st March 1878 ...	11,698 6 3	
Sanctioned establishment	22,741 2 6	
House rent	4,164 9 0	
Contingencies	1,788 5 3	
		40,392 7 0
Chemicals and stores received from England as far as known ...	3,426 0 0	
Ditto received from Government Medical Stores ...	54 0 0	
Stores and materials received from other Government Departments ...	304 0 0	
Cost of paper received from England, and Government Stationery Department, as far as known	21,254 0 0	
		25,038 0 0
Cadastral Surveys, N. W. P.	14,302 12 3	
Establishment		
Contingencies	1,963 1 3	
Extra men up to December 1877	1,362 6 10	
		17,628 4 4
Chemicals and stores received from England as far as known ...	18,167 0 0	
Ditto received from Government Medical Store Department	109 0 0	
Stores and materials received from other Government Departments ...	1,050 0 0	
Cost of paper received from England and Government Stationery Department, as far as known	10,488 0 0	
		29,814 0 0
Total Rs.	.....	1,12,872 11 4

Personnel.

5. There have been a few changes in the staff during the year. Mr. V. Leroy, of the Cadastral establishment, died on the 19th March, and his place was filled up by the appointment of Mr. T. Lloyd, who had previously been employed in the Photographic Branch of the Computing Office of the Trigonometrical Branch at Dehra Dun. Mr. A. E. Caddy was appointed to the Cadastral establishment in April, and has been placed in charge of the stores and store accounts. The principal assistants, Messrs. J. Mackenzie, B. Mackenzie, Watson, Harrold, Marshall, George, Lagnier, Dempster, and Syud Ishmael, have all worked well during the year. During my absence on three months' privilege leave and one month's special duty in Europe, from July to November, Captain S. H. Cowan took charge of the Office.

Cadastral maps of the North-Western Provinces.

6. The arrangements for reproducing the Cadastral Maps of the N. W. Provinces are now finally in full working order, and the out-turn for the year has reached the point originally estimated for. The reduction in the number of copies printed of each sheet has necessitated the reproduction of more sheets daily than were originally estimated for, in order to keep all the presses at work. Arrangements have therefore been made to turn out 14 to 16 sheets daily from the cameras, and these will be further supplemented by tracings for transfer to zinc direct without photography, so as to bring the total out-turn of the presses to about 18 sheets a day. I am glad to be able to report that the sheets now received for photographic reproduction do not give so much trouble in potographing or require so much correcting on the zinc as the earlier ones did.

Cadastral Maps of Bengal.

7. With the object of giving all possible help in reproducing some of the Cadastral Maps of Bengal, two spare presses have been utilised and a small additional staff of printers and pressmen entertained to work them. Since April 1878, the out-turn has been 865 sheets, giving 43,000 copies. These sheets are traced with lithographic ink and transferred direct to zinc without any photography. The whole expense connected with preparing the tracings and printing is arranged for by the Revenue Branch.

Processes—Negatives.

8. The processes for obtaining negatives have remained the same as last year, but we have found it convenient to substitute a coating of gelatine for the resinous varnish generally used. This costs less, and the films are more readily removed from the glass.

The proportions of the gelatine solution are—

Gelatine	...	20 grammes,
Water	...	1 litre,

with a trace of chrome alum.

During a great part of the year under report, the collodion used was made up in the office from materials received from England.

The following formula has been found to answer well, and the cost is about half that of English-made collodion.

Plain Collodion.

Pyroxyline	...	60 grammes.
Alcohol	...	1 litre.
Ether	...	2 litres.

Iodiser.

Ammonium Iodide	...	20 grammes.
Cadmium "	...	12 "
" Bromide	...	8 "
Iodine	...	0·3 "
Alcohol	...	1 litre.

Photo-transfers.

9. The new method of preparing the photo-transfers reported on last year has been in use all the year through for the ordinary office work, and under favourable conditions is found to answer better than the ordinary method for fine and close work. The paper is now prepared by giving it two coats of biehromate and gelatine according to the ordinary formula, and allowing it to lie by for 3 or 4 days in the hot weather and 12 to 14 in the cold weather, and then re-coating it when required for use with a thin mixture of gelatine and bichromate containing double the usual quantity of water.

The transfer ink has also been altered, and the formula is now—

Hard re-transfer ink	...	32 parts.
Lithographic printing ink	...	24 "
Southampton ink	...	8 "
Tallow	...	1 part.

This works better, and less is used of it.

10. Further experiments with this process have enabled me to overcome some of the difficulties first experienced, but I have not yet been able to determine the kind of tissue best suited for the purpose. Some tissues otherwise good will not take the grain with the tannin, and others which take the grain well do not give a sufficiently clear image. Further experiment is necessary in this direction, and it will, I think, be desirable to investigate the subject fully, so that we may be able to prepare our own tissues according to standard formula. The Autotype Company have kindly undertaken to prepare me some special tissues for the purpose, and I am looking for their arrival daily to re-commence my experiments.

Photo-engraving.

11. During my leave to Europe I was able to pick up some useful hints on the process, though I found that the best results were produced by methods almost the same as that I have been working here, with the exception of the method of getting the grain, which was my own discovery. I believe, therefore, that the process is the best that can be adopted, and hope I shall be able to perfect it for the practical use of the Department.

12. I have found it a great improvement to effect the deposition of copper on the gelatine relief horizontally, instead of vertically. In other respects, the process remains at present the same as reported last year.

13. During the year some experiments were tried with a method of collotype in which the negative is taken direct on a thick glass plate. Before it is allowed to dry, the plate is coated with a mixture of bichromate and gelatine suitable for collotype printing, and then dried in the dark. The sensitive film is then exposed to light through the glass, the printing surface being carefully covered over to protect it from all access of light. After exposure the gelatine surface is washed to remove the bichromate and is then ready for printing. The advantages of the system are its not requiring a reversed negative, and absolute accuracy of scale in the prints.

Collotype.

It was found to answer well for line subjects, but not for those with half-tones, which, of course, detracts much from its value.

Statement showing the work done for other Departments from 1st October 1877 to 30th September 1878.

Names of Departments.	Number of Section.	Number of Negatives.	Number of complete copies.	Number of silver prints.	Cost. Rs.	A.	P.	Remarks.
Government of India, Foreign Department ...	3	7	187	...	49	3	6	
Do. do. Military do. ...	10	15	700	26	235	4	8	
Do. do. Public Works do. ...	7	13	445	50	214	15	2	
Do. of Bengal, do. do. ...	8	16	420	...	190	0	0	
Do. of Punjab, do. do. ...	1	1	200	...	50	0	0	
Do. of North-Western Provinces, P. W. D.	21				284	9	0	
Do. of India, Public Works Department, Railway	19	21	7,350	6	555	11	11	
Inspector-General of Military Works ...	23	39	2,755	...	1,009	9	5	
Quarter-Master General in India ...	35	45	6,400	...	1,843	13	8	
Superintendent of Garrison Instruction ...	17	19	1,475	...	244	10	10	
Inspector-General of Ordnance and Magazines ...	1	2	100	...	35	0	0	
Executive Engineer, 1st Calcutta Division ...	1	1	11	...	16	0	0	
Superintendent of Forest Surveys	2	3	980	...	165	6	0	
Marine Survey Department	25	84	6,475	...	2,591	8	8	
Port Officer	7	27	550		406	8	6	
Port Commissioner	7	26	286	98	90	0	6	
Post Master General	73	37	37,960	...	650	0	0	
Geological Survey of India	3	7	3,002	...	563	11	0	
Meteorological Department	2	2	24	...	10	15	10	
Railway Transport Committee	7	4	2,400	...	80	0	0	
Rajputana State Railway	10	8	2,420	...	100	11	6	
Tirhoot State Railway	14	14	1,350	...	200	0	0	
Holkar and Neemuch State Railway	1	1	505	...	16	7	0	
Chief Engineer, East Indian Railway	1	2	110	...	4	14	10	
Famine Committee	1	1	...	...	*7	0	0	Printed in October 1878.
Principal Medical Store-keeper	1	1	50	...	16	0	0	
Asiatic Society of Bengal	5	5	7,101	...	218	13	2	* Cost of negatives.
Dr. Rajendralala Mittra, Rai Bahadur, C. I. E. ...	3	5	615	12	81	13	0	
Trustees, Indian Museum	1	1	...	3	1	10	0	
A. O. Hume, Esq., C. B.	1	1	450	...	25	12	0	
Rangoon Municipality	35	132	...	...	†838	0	0	Not printed.
Consulting Architect to the Government of Bengal	1	1	...	3	8	1	0	† Cost of negatives.
Solar photographs for the India Office, Geographical Department, London	...	...	...	196	89	3	6	
Total ...	344	615	96,161	324	10,895	6	8	

SURVEYOR-GENERAL'S OFFICE,
PHOTOGRAPHIC BRANCH,
Calcutta, 27th December 1878.

J. WATERHOUSE, *Captain,*
Asst Surveyor-General, in charge Photographic Branch.

Extract from Report No. $\frac{33}{P}$, dated 14th December 1878, by CAPTAIN J. WATERHOUSE, S. C., *on recent progress in Europe of Photography as applied to the Reproduction of Maps, &c.*

I have the honor to submit, for the information of the Government of India, the following brief report of the observations on the recent progress of Photography as applied to reproduction of maps, &c., and other matters connected with the work of this office, I made while on leave and duty during my recent visit to Europe.

Ordnance Survey Office, Dublin.

2. Being at the meeting of the British Association in Dublin, I took the opportunity of visiting the Ordnance Survey Office in that city, under the charge of Major Wilson, R. E., C. B., and paid particular attention to the electrotyping arrangements which, though differing in some respects, are similar to those at the Ordnance Survey Office, Southampton, namely, Smee's batteries, with horizontal depositing troughs kept in constant motion by a small steam engine.

Steel facing at Messrs. Malby and Company's.

3. As some difficulty has been experienced in working the process of steel facing copper-plates in Calcutta, I called on Messrs. Malby and Company, London, to ascertain, if possible, how these difficulties might best be obviated. Mr. Malby kindly let me see the process in operation, and gave me some hints on the subject, promising me any assistance he could give if we still had any difficulty in working the process.

Messrs. Standford and Company.

4. Having a letter of introduction to Mr. Bolton, the Manager of Messrs. Stanford's cartographic establishment in Long Acre, I visited it, and was particularly interested in the working of a machine for reducing and enlarging maps on sheet India-rubber, and which in many cases appears to give better results than could be obtained by photography, while it is naturally cheaper and more simple in working.

Ordnance Survey Office, Southampton.

5. I spent a day at the Ordnance Survey Office, Southampton, and with the kind permission of Colonel Carey was able to see the Drawing, Photographic and Printing branches. The photographic processes I found had not been changed since my previous visit in 1868, nor had any new processes been adopted.

6. I also saw the electrotyping, which was of special interest because experiments were being made with Clamond's thermo-electric piles, in which the electric current is generated by a single gas flame, and the zinc plates, acids, &c., used in an ordinary battery are done away with. I was told that the piles worked very well.

7. My attention was drawn to a very fine, thin tough paper used for printing maps upon, if likely to be exposed to constant folding or rough usage. It is made by Messrs. John Dickinson and Company, of the Nash Mills, Hemel Hempstead. As such paper is constantly wanted in the Calcutta Office, I asked the authorities at the India Office to send out a small quantity for trial.

Dallastint and Dallastype.

8. I visited Mr. Duncan Dallas of Gray's Inn Road, London, who has had great experience in photographic engraving. He showed me some of the results of his processes of Dallastint for intaglio and surface printing of subjects in half tones, and Dallastype for surface printing of subjects in line, but would give me no information as to how they were obtained.

Messrs. A. & W. Dawson's, photo-relief processes, &c.

9. When passing through Paris on my way to London, I went through the Paris Exhibition, and noticed some excellent specimens of typographic etching and photographic engraving, both from blocks for surface printing and from intaglio plates, exhibited by Messrs. A. & W. Dawson of Farringdon Street, London.

10. On visiting them, Mr. Alfred Dawson, the senior partner, was kind enough to invite me to see their works at Chiswick and to give me almost full information of the various processes they used, on the understanding, however, that, though I was at full liberty to use this information in the office at Calcutta, I should not publish it.

11. The processes on which I obtained information from Messrs. Dawson were—

1st.—The typographic etching, by which blocks are produced direct from an artist's drawing for printing with type. The method is an improvement on Palmer's process of "Glyphography."

2nd.—A photo-typographic process for producing blocks for letter-press printing.

3rd.—A photo-mezzotint process for producing intaglio plates for printing in the copper-plate press. This last process was the one which interested me most, especially when I found that it was in some respects similar to the one I had been working in Calcutta.

12. Mr. Dawson also gave me some information on the methods of electrotyping he used in the above processes, and I have to warmly acknowledge the unusual liberality with which he gave me so much information upon processes he was working commercially.

Messrs. Leitch and Company.

13. I paid a visit to Messrs. Leitch and Company, also of Farringdom Street, who work various processes of photo-engraving and gillotype. They were, however, unwilling to show me their works or give me information as to the processes they used.

Autotype Company.

14. On the kind invitation of Messrs. Sawyer and Bird, Managing Directors of the Autotype Company, I spent a day at their works at Eling Dene, and saw the various operations connected with the working of their processes of pigment printing, or autotype, and photo-mechanical, or collotype printing, and was able to gather a good deal of information about them. I also had a talk with Mr. Sawyer on the subject of supplying tissue for my photo-engraving process, and he kindly promised to prepare and send me some specimens of various tissues which he thought would probably be suitable for the purpose.

Woodbury Photo-printing Company.

15. On the invitation of Mr. Whitfield, of the firm of Lock and Whitfield, who are the principal proprietors of the Woodbury patents, I visited the Woodbury Photo-printing Company's works at Eling and saw the operations connected with the Woodbury-type and pigment printing processes, some of which were new to me.

Messrs. Hopkin and Williams.

16. I took the opportunity of seeing Messrs. Hopkin and Williams, the chemists, from whom most of our supplies of chemicals are obtained, to make enquiries on certain points connected with the supply and putting up of pyroxyline and other chemicals for the office, and obtained some useful hints on the subject.

Mr. Winstone.

17. With the same object I visited Mr. Winstone, of Shoe Lane, who supplies the office with lithographic and printing materials. He showed me some novelties, particularly a new lithographic roller made of India-rubber and known as "Lanham's patent Victory roller." I made further enquiries about these rollers from the manufacturers, Messrs. Blades, East and Blades, of Abchurch Lane, and as they seemed to have many good qualities, I thought it might be desirable to try them in India, and therefore asked the authorities at the India Office to send out some to Calcutta for trial, both lithographic and letter press. Mr. Winstone gave me for trial samples of a new transfer-writing-ink and of a liquid called "Lithophine," which is said to be useful in preparing transfers and bringing up old work on the lithographic stone.

Messrs. Bradbury and Wilkinson.

18. To obtain information on the commercial methods of electrotyping engraved plates, I obtained an introduction to Messrs. Bradbury and Wilkinson of Farringdom Road, and saw the processes of electrotyping and steel facing, which, however, presented nothing very new.

Nickel Plating Company.

19. Being desirous of knowing if engraved copper-plates could be more advantageously protected by coating them with nickel instead of iron, I visited the Nickel Plating Company's works in Hatton Garden and saw the process of nickel plating in operation. My attention was drawn to Weston's Dynamo-electric machine, by means of which the electric current is generated, and I made further enquiries regarding the machine from the sale-agents. It appears well adapted for use when an intense current is required acting during a short time, but I was told that it is not suited for depositing copper in thick deposits.

Platinum Printing.

20. My attention having been drawn by Captain Abney and others to the advantages of the platinum-printing process, invented and lately improved by Mr. W. Willis, junior, of Bromley, Kent, I paid that gentleman a visit and saw the process in operation. It appeared to have so many advantages over the ordinary silver-printing process in its greater rapidity, simplicity, and absolute permanence of the results, that I thought it desirable to purchase the right of using the process in India, and accordingly asked the Secretary of State to make the necessary arrangements, or allow me to do so from the funds granted me by the Government of India. As the time at my disposal was very short, the Secretary of State gave me authority to conclude any arrangements I thought desirable, if I considered the process would really be of value. I therefore arranged with Mr. Willis for the purchase of the right to use the process, and full information as to the manipulations, on payment of a sum of £10-10, and for the purchase of sufficient materials for working half a ream of paper at a further cost of £9-15, it being understood that all special chemicals required for working the process should be purchased from Mr. Willis or his agents.

21. From what I saw of the process, and heard of it from others, I believe that it will prove of very great use in all cases where silver-printing is now used, and is better for India as a permanent process than pigment-printing by the autotype method, and not more expensive.

22. The above visits and others made to Captain Abney, the editors of the Photographic Journals, &c., were all made between the 5th August and the 15th September, and though they do not appear many, they took up a good deal of my leave.

23. Having received intimation from the Secretary of State for India that he had sanctioned my detention in Europe for one month on duty for the purpose of visiting the Paris Exhibition, and also that he was desirous that, if time permitted, I should visit Vienna to obtain information on the process of photo-engraving known as *Heliogravure* practised at the Military Geographical Institute, I started for Paris on the 14th September.

24. After a preliminary visit to the Exhibition, and a special inspection of the specimens of photo-mechanical printing exhibited in the French section, I judged it better to try to obtain information about the various processes exhibited by residents of Paris before making a detailed study of the specimens exhibited from other countries, and regarding which no information could be obtained beyond what one could gather from mere inspection.

25. I therefore visited the principal exhibitors, some of whom I had already met when at Paris in 1868, and to most of the others I was able to obtain introductions.

M. Erhard's process of Chemical Engraving.

26. M. Erhard, to whom I was indebted for a good deal of information on the occasion of my last visit to Paris in 1868, showed me some specimens of a new process of chemical engraving, by which a transfer made on to a clean, polished copper-plate from an engraved copper-plate or stone, is beaten in so as to produce an engraved plate, which, having been steel-faced, can be printed from to any extent. The process seems to be largely used by the Marine Department for the reproduction of charts, &c. The advantage claimed for the process is that engraving on stone is considerably cheaper than engraving on copper and takes less time, while the results are scarcely inferior in quality. The engraved stones, however, are bulky, and soon wear out in printing, it is therefore an advantage to transform the engraving on stone into an engraving on copper, and thus obtain a plate that takes but little storage room, is not liable to break, and may be printed from almost indefinitely.

27. I saw some of the plates before and after the etching operation, but did not obtain any details of the process. The results appeared to me very good indeed.

28. At M. Erhard's I also saw the engraving of maps on stone, for which the establishment is famous, but did not observe any novelties. I noticed, however, a method of drawing hills on stone with a stump, which appeared very effective, and was, I was told, much quicker, and consequently cheaper, than the ordinary method of drawing in chalk.

M. Baldus.

29. M. Baldus, whom I had met in 1868, showed me some specimens of photo-engraving in half tone, which were interesting as being produced, as I was able to see, by an etching process, but the results did not seem equal to those produced by the electrotyping methods, and appeared to require a good deal of touching up.

30. I was particularly anxious to see the working of the Collotype and Woodbury processes at the office of the *Moniteur*, where very extensive and complete arrangements have been made for working them; but M. Leon Vidal, the Director of Works, to whom I had an introduction, told me that the Managers of the Company had forbidden the showing of the works to strangers, and so I was unable to see them. M. Vidal explained to me the method by which his photo-chrome prints were produced.

M. Geymet.

31. M. Geymet, to whose work on the subject I am in great measure indebted for the process of photo-engraving I have worked in Calcutta, showed me some specimens of photo-engraving and collotype printing, but could not show me the processes in practice, because his workshops were in disorder owing to his removal from other premises.

32. Messrs. Yves and Barret, who exhibited some excellent specimens of maps in relief on zinc plates, showed me some specimens of their work of various kinds, but were unwilling to let me see their workshops, or to give me any information regarding their processes.

M. Dujardin.

33. Some exceedingly fine specimens of photo-engraving in line and half tone were exhibited by M. Dujardin. I had a long conversation with him on the subject, but obtained very little information as to his methods, which he led me to believe were quite new and differed from those hitherto employed.

Madame Veuve Gillot et Fils.

34. Madame Gillot, widow of the inventor of the zinc relief process known as paniconography or gillotage, and her son, who work this process very extensively, both with and without the aid of photography, very kindly permitted me to see their workshops, where I found much that was new and interesting, especially in the photographic part of the process.

M. Amand Durand.

35. I called on M. Amand Durand, whom I had known in 1868, and who has made a speciality of reproducing the etchings, and engravings of the old masters by photo-engraving. I did not, however, get much new information from him as he has confined himself entirely to the reproduction of subjects in line.

36. Having obtained an introduction to M. Rousselon, the Manager of Messrs. Goupil's photographic printing works at Asnières, who has brought to very great perfection the reproduction of paintings by a photographic-engraving process, I visited these works and, though I could not obtain very much information regarding the principal photographic operations, I saw a great deal that was interesting, especially the electrotyping of the plates by means of the Clamond's thermo-electric piles before alluded to, and M. Rousselon spoke very highly of their working during the five years he had had them in use.

Messrs. Goupil and Co.

37. Having obtained the necessary authorisation through the British Embassy, I visited the Cartographic Department of the Depôt de la Guerre and the Imprimerie Nationale.

38. I found the photographic department of the Depôt de la Guerre much as it was in 1868, both as to arrangements and processes, but I was shown a very simple pigment printing process suitable for line subjects, and which seemed to be used to a considerable extent instead of silver-printing. A sheet of paper brushed over with glues, gum or albumen coloured with Indian ink* is sensitised by floating it back downwards on a solution of bichromate of potash. When dry the paper is exposed to light under an ordinary negative, then soaked in water and the image is developed by washing off the soluble coating with a broad soft brush. The process is simple and cheap.

Depôt de la Guerre.

39. The engraving and electrotyping branches also presented some new features of interest. M. George's method of preparing copper-plates for correction by electro-deposition, described in my Report on the Cartographic Applications of Photography, is still in use.

40. I was shown an ingenious method of making up copper-plates in cases where a town falls in the corner of an engraved sheet, and it is desired to have it in the centre of a sheet with the country surrounding it on the same sheet.

41. Thin electrotype reliefs are taken from the engraved copper-plates of 4 contiguous sheets. They are cut very exactly from the back and then fastened down face upwards in their proper position on another copper-plate. The details along the lines of junction are scraped away for about 1 centimetre, and an electrotype is made from the combined plate. The missing details along the junctions are re-inserted and the 4 sections assimilated as far as possible. These plates are termed *planches bis* and are designated after the principal town, *e. g.*, ORLEANS BIS. The results I saw of this method were exceedingly good, and showed no trace of the means by which they had been obtained. A similar method is also in use at the Ordnance Survey Office, Southampton.

42. The electrotyping is carried on entirely by means of the Clamond thermo-electric piles, and they are also used for steel-facing. The deposition is effected vertically, and, by an ingenious arrangement, two plates can be deposited at the same time from one anode.

43. In one of the printing rooms I saw a machine for zinc printing made by Wibart of Paris, which had the peculiarity that very thin sheet zinc was used for printing and the sheets were bent into a cylindrical curve. The machine was worked by hand, but would be more effective if worked by a small engine. I was told, however, that it was not yet very perfect. I also saw a very convenient portable lithographic press made by Lagrange of Paris for use in the field.

44. At the Imprimerie Nationale I found that little or no photography was done, though there was a small photographic atelier for the purpose. The only process that particularly engaged my attention was the *gillotage* for producing reliefs on zinc for letter-press printing, and I saw a good many details of the process that were new to me. I was told that photography is occasionally used for producing the designs on the zinc plate, the sensitive composition being bitumen; but as the assistant who had charge of the photographic operations was absent, I could obtain no details of the manipulations.

Imprimerie Nationale.

45. I also saw the electrotyping. The system employed was the vertical single cell arrangement that I saw in use 10 years ago.

46. I spent several days in the Exhibition, my attention being specially directed to the specimens of photo-mechanical printing and maps, though I also examined the printing presses and appliances in the French Section.

The Exhibition.

47. In the English Section the photo-mechanical processes were not largely represented, there being only two principal exhibitors, Messrs. A. & W. Dawson and Company, and the Autotype Company, who both showed some excellent specimens of their processes, already noticed in paragraphs 11 and 14.

England.

48. Mr. L. Warnerke exhibited some good specimens of a photo-typographic process for producing surface blocks.

49. In the United States Section the only specimens of photo-mechanical printing I could discover were some photo-lithographs in the portfolios of maps exhibited by the Geological Survey. Copies of these are in the Surveyor-General's Office.

United States of America.

* The paper employed at the Depôt de la Guerre is prepared by M. Artigue of Bordeaux, and the composition of the coating is a secret. It is said to consist of gum, dextrine, albumen and animal black.

50. In the Italian Section there were some excellent collections of views printed by the collotype process and exhibited by G. B. Brusa of Venice, and some views of Rome printed in the same manner by Danesi.

Italy.

51. The Italian Government exhibited a series of maps produced by Avet's method of photo-engraving. These maps were exceedingly fine and delicate, and could scarcelybe distinguished from maps engraved by hand.

52. They are reproduced on the scale of 1 to 100,000 from original drawings on the scale of 1 to 75,000. The original drawings were not exhibited, but only photo-lithographs of them, and these are published on the full scale for the use of Government officers and the public.

53. Avet's process of photo-engraving was patented in the year 1865, but it is probable that since that time some modifications have been introduced. As published, it consists in coating a glass negative with a mixture of gelatine and bichromate of potash. When dry, the uncoated side of the plate is exposed to light, and an image in relief developed by washing the plate in warm water. The relief is metallised by treatment with nitrate of silver and then electrotyped.

54. In the Dutch Section, the War Department exhibited several fine specimens of maps and pictures of Artillery material produced by Eckstein's method of tint engraving on stone on a photographic basis, described in my Report on the Cartographic Applications of Photography; but so far as I could discover, there were no other specimens of maps produced by photography.

Holland.

55. Mr. Asser of Amsterdam, one of the earliest workers in photo-lithography, exhibited an interesting series of specimens of photo-lithography produced by his process, as well as the negatives, stones and transfer prints, inked and uninked.

56. In the Portuguese Section the Government exhibited a large and highly interesting collection of specimens of maps and other subjects illustrating the photographic processes employed at the Geographical Institute, Lisbon, under the superintendence of M. Rodriguez. These specimens included negatives, photo-transfer prints on tin-foil for transfer to zinc without stretching, zinc plates with transfers on them (these were of very thin sheet zinc), and proofs from the plates.

Portugal.

57. There were also some examples of a process of photographic-engraving, in which the necessity of making a photographic cliche is avoided by drawing on a plate of ground glass, prepared for the purpose by rubbing it over with powdered sandarac by means of a pad of cotton. The ink used is Indian ink, rubbed down with a little sugar or glycerine. When the drawing has dried the surface is rubbed with a pad dipped in fine plumbago. This makes the drawing perfectly opaque. The drawing is then impressed by light in the usual way on a copper-plate coated with bitumen; after exposure, the plate is developed with a suitable solvent, which leaves the design in bare copper on a ground of bitumen, and by etching with acid, an engraved plate is produced.

58. The maps exhibited were almost all printed from zinc plates in relief, about double elephant size, and produced by gillotage. The impressions seemed very sharp, firm and clean.

59. M. Rodriguez also exhibited some interesting specimens of relief etching applied to subjects in half-tone, but they were not quite a success.

60. The National Printing Office, Lisbon, exhibited some photo-galvanographs in half-tone and line by M. Leipold. The former were not particularly good.

61. In the Luxembourg Section two maps were exhibited, produced by the cyanotype process.

Luxembourg.

62. In the Danish Section some exceedingly well engraved maps were exhibited, and also some photographs, which, however, presented nothing particularly worthy of notice.

Denmark.

63. In the Belgian Section there was a large collection of specimens of maps produced at the Depôt de la Guerre, Brussels, by chromo-photo-lithography and photo-zincography. The former were the same as those I saw in 1868. The photo-zincographs are of more recent introduction, and are very good. They are published on two scales, $\frac{1}{10,000}$ and $\frac{1}{20,000}$; the latter being reduced, are the best. These maps are very cheap, being sold to officers at 15 centimes per copy, and to the public at 30 centimes, the size being about 16″ × 18″. I noticed some very good reductions from the scale of $\frac{1}{80,000}$ to $\frac{1}{80,000}$ by means of a pantograph made by Messrs. Simon of Nottingham, which is, I believe, an India-rubber machine.

Belgium.

64. I saw no specimens of maps produced by photo-engraving, though I believe the process has been worked in the *Depôt de la Guerre*.

65. In the Swiss Section no photographed maps were exhibited by the Government, but only specimens of the engraved maps of Switzerland and some of the original drawings from which the celebrated map on the scale of 1 to 100,000 was engraved.

Switzerland.

66. Messrs. Orell Fusele & Co. of Zurick, exhibited some specimens of *Gravure photo-chimique*, but there was nothing to show how they had been obtained.

67. Messrs. Mullhaupt and Sons, of Berne, exhibited some excellent maps in a style peculiar to themselves, by which the horizontal contours are given, and the hill shading shown in strong relief by stump shading and rouletting. They also showed specimens of coloured maps printed from engraved copper-plates.

68. In the Russian Section no maps were exhibited by the Government, and though some of the maps of the Russia General Staff were exhibited by the sale agent, A. Illyne, they were mixed up in portfolios with other things and could not be readily examined.

Russia,

69. The Russian State Paper Office exhibited a splendid collection of plates and proofs of photo-engravings in line and half-tone by Herr G. Scamoni, both relief blocks for surface printing and intaglio plates for copper-plate printing. I noticed that some of the plates and blocks appeared to be nickel-faced.

70. In the Austrian Section I was disappointed to find that neither the Military Geographical Institute, nor the Government Printing Office at Vienna, had exhibited, because in 1867 the Government Printing Office sent a remarkably fine collection of its productions.

Austria,

71. The private firms of Zamarski and Max Jaffe, of Vienna, exhibited some good examples of photo-engraving and relief printing on zinc.

72. The absence of any exhibits relating to photography from the German States is to be regretted, because the *licht-druck* and other photo-mechanical processes have been carried to a great pitch of perfection in North Germany and Bavaria; and in the Exhibition of 1867 the German Section contained a good deal that was interesting in this respect.

Germany,

73. The French Section naturally contained the largest collections both of maps and specimens of photo-mechanical printing.

France.

74. The Depot de la Guerre exhibited a large collection of the various maps produced there, particularly a complete mounted copy of the Map of France on the scale of 1=80,000. This, however was placed at such a height that a telescope was required to read it. There was also a series of plates illustrating M. George's method of correction and the construction of the *planches bis* by electrotyping, as already described in paragraph 41. Some photo-zincographs and photo-engravings were also exhibited by the Depôt, as well as some typographic reproductions of the Map of France on the scale of 1 to 80,000 executed by Messrs. Yves and Barret.

75. The Ministére de la Marine exhibited charts and maps, but, as far as I could see, none produced by photography.

76. The Depôt des Fortifications exhibited plans and surveying instruments. The plans included original field surveys on scales of 1 to 1,000, 1 to 2,000, 1 to 10,000, and photographed copies of the surveys on the scale of 1 to 10,000 reproduced to scale and reduced one-half; a Map of France on the scale of 1 = 500,000, some sections of which were reproduced in photo-engraving by M. Dujardin; various maps showing different methods of topographical drawing and modes of lighting; relief plans.

77. The numerous specimens of photo-engraving, photo-typography, and photo-collotype printing, exhibited by private individuals in the French Section, were very interesting and showed a considerable advance in these branches since 1867.

78. In photo-engraving the principal specimens were exhibited by Messrs. Goupil & Co., and comprised copies of paintings, some of comparatively large size. The details of the process by which they are produced has not been published, but the process has been carried to great perfection by M. Rousselon and leaves little to be desired.

79. M. Dujardin Exhibited several excellent specimens of photo-engraving in line and half tone. A reproduction of a map in line was particularly clear and fine. His prints in half tone were also exceedingly good. As before stated, M. Dujardin keeps his process perfectly secret.

80. M. Placet, who was one of the earliest to produce good photo-engravings in half tones without retouching, exhibited a few specimens which did not, however, appear to show any particular advance over his earlier ones.

81. M. Garnier, who took the gold medal in 1867 for photo-engraving, exhibited several specimens in line and half tone. He also showed specimens of a new process of chemical engraving giving very good results.

82. M. Baldus exhibited several specimens of photo-engraving in line and half-tone, specially interesting as being produced by an etching process with bichromated gelatine.

83. M. Michaud, of Grenoble, exhibited specimens of his new photo-c[illegible] in relief and intaglio. These processes seemed to give good results, and the de[illegible] have been partly published.

84. In photo-typography, the firms of Veune Gillot et Fils and Yves and Barret were the principal exhibitors. The majority of the exhibits of both firms were illustrations for books and newspapers; but Yves and Barret also exhibited some full-sized maps in relief on zinc, which were of interest.

85. The best specimens of collotype printing came from the *Ateliers de Photo-chromie* attached to the offices of the *Moniteur*, and comprised uncoloured copies of tinted drawings by the ordinary collotype process, and also coloured prints produced by M. Leon Vidal's system of photo-chromy, in which a photographic print is impressed over a roughly-coloured basis printed by the ordinary operations of chromo-lithography.

86. The other principal exhibitors of collotypes were Braun of Dornach; Berthaud, Lemercier, and Arosa, of Paris, and Quinsac of Toulouse; but, with the exception of the first, their productions seemed scarcely equal to work done in England and Germany.

87. The Woodbury process, or, as the French call it, "*photoglyptie*," was well represented in the French Section by the houses of Goupil and Braun; but as this process is not suitable for cartographic purposes, I did not give any special attention to the specimens exhibited.

Clamond's thermo-electric piles.

88. While in Paris I took the opportunity of seeing M. Clamond, the inventor of the thermo-electric pile, with a view to obtaining information regarding it. M. Clamond showed me a new pile he was constructing, which he said was better in many respects than his former one, and could be used with any kind of heater; and he promised me particulars as to price, &c., as soon as he was in a position to supply them.

Derogy's reversing lens.

89. M. Derogy of Paris has lately brought out a lens for producing photographic negatives, reversed by means of a small reversing prism placed between the lenses. As a simple system of producing reversed negatives is a great desideratum in photo-mechanical printing, I was anxious to test the working of one of these lenses and made arrangements with M. Derogy for a trial. I found, however, that his appliances were quite unsuitable for a thorough examination of the lenses for copying purposes, and unfortunately time did not allow me to endeavour to arrange for a trial at the *Depôt de la Guerre* or elsewhere.

90. From the rough trial I made, the lens seemed to answer very well, and though further and more rigid trial might prove it unsuitable for copying maps, it would, I believe, do very well for all ordinary purposes of landscape and studio work.

Departure for Vienna.

91. I had originally intended to leave Paris on the 7th October at latest, so as to be able to have a full week in Vienna, but unfortunately I had a bad sore throat at the time, which kept me to the house for two or three days and prevented my leaving for Vienna till the evening of the 10th. I had also proposed to visit Munich to see the working of Albert's *Licht-druck* or collotype process, but I found that the time at my disposal would not allow of this.

Arrival at Vienna.

92. I arrived in Vienna on the 12th October, and found that, in accordance with my request, the British Embassy had kindly obtained for me the necessary authorisations to visit the Imperial Military Geographical Institute and the State Printing Office, so that I had no delay in at once visiting these Institutions.

Military Geographical Institute.

93. At the Military Geographical Institute I was received with cordiality by the Director Lieutenant-Field-Marshal Guran, who told me that the details of the photo-engraving process would be communicated to me. Unfortunately the weather was very wet and dark at the time of my visit, and my time was so short that I could not stay to see the process actually worked through, but the Officer in charge of the Photographic operations, Captain Schonhäber von Wenderoth, kindly gave me a full description of it and other processes used, and showed me round the photographic rooms.

94. The engraving process I found to be very similar to the process I had been working in Calcutta. I obtained, however, some useful hints as to the production of the reversed negatives and the composition of the gelatine tissue used for making the reliefs, as well as upon the electrotyping of them. Captain Schonhäber particularly requested me not to publish the details of the process.

95. Captain Schonhäber gave me the details of a simple collotype process in which a peculiarly prepared gelatinised paper is applied with wax to a zinc plate, and the photographic image impressed on it after a second sensitising. I also saw the working of a method of photo-lithography, which presented some new features of interest in the preparation of the transfers, which were inked up with a velvet roller. The arrangements of the copying apparatus, rooms and laboratories, was much the same as when I was there in 1868. It is to

[illegible]e and weather did not allow me to see more of these interesting processes [illegible]ed.

State Printing Office.

96. At the State Printing Office I found that very little photography was being done. I saw, however, the arrangements for collotype printing, and paid particular attention to the electrotyping and steel-facing. The former was on the same system as I saw in use in 1868.

C. Haack and Co.

97. At a meeting of the Vienna Photographic Society, I was fortunate enough to meet Mr. Ebeling, of the firm of C. Haack and Co., Photo-zincographers, who kindly invited me to visit their work-rooms, where I saw some excellent specimens of zinc printing in relief. Mr. Haack had also been experimenting upon photo-engraving in half-tones by a process very similar to my own.

98. Time unfortunately did not permit me to take full advantage of the opportunity of being in Vienna to see much that would have been of interest. I started for Venice on the 16th, and embarked for India at the latter place on the 18th October.

99. It will be seen from the above account that although, owing to the shortness of the time at my disposal, I was unable to go very thoroughly into any of the subjects I was investigating, I obtained a good deal of information regarding them, and was able to ascertain in a general way what new processes have been introduced since I was last in Europe, and what were likely to be useful in India. It may, perhaps, be of interest if I briefly sum up the results of my observations on the principal processes to which my attention was given.

Photo-lithography and Photo-zincography.

100. Photo-lithographic processes still continue to be used in the institutions in which I saw them in 1867-68, and the use of photo-zincography appeared to be extending in the *Depôts de la Guerre* in Paris and Brussels. I noticed a tendency to work with an insoluble coating of gelatine on the transfers instead of dissolving away the gelatine, as in the Southampton process, and a similar method has been in use for the past year in this office with the object of better retaining fine details. The method of inking in the transfers I saw used at Vienna may be worth trial.

Photo-typography.

101. Photo-typographic processes appeared to be much more largely used than when I was in Europe in 1867-68, especially in connection with the method of gillotage or relief etching on zinc plates, and seemed to have been brought to a great pitch of perfection in London, Paris and Vienna, for illustrations of books and newspapers of all kinds. The process, however, demands a good deal of care and skill; and until a greater demand for such work arises, I do not think it worth while introducing it, or the other equally good process with swelled gelatine, into the office, and if any such process is required I would recommend that the right of using Messrs. A. and W. Dawson's patents should be required.

102. I observed that several attempts had been made to obtain printing blocks from photographs in half-tone, but, with very few exceptions, the results could not be considered satisfactory. The success already attained seems, however, to make it probable that in time successful results may be produced.

Photo-engraving.

103. Photo-intaglio engraving, though not yet by any means common, has certainly made great advances during the last 10 years, especially in the reproduction of subjects with half-tones. It has been definitely and very successfully adopted as the means of producing the Government maps in Italy and Austria from original drawings in pen and ink, but otherwise does not seem as yet to be used to any extent for the reproduction of maps. At present, the professional workers appear to be most numerous in France; and in the hands of Goupil, Dujardin, Amand Durand, Baldus and others, photo-engraving, both in half-tone and line, has taken an important place among reproductive art processes, and it is, I believe, destined before long to be very much more largely used than it is now.

104. It was somewhat gratifying to find that some of the best results in half-tone work and also in line had been produced by a method similar to the one I had adopted and worked out in Calcutta. This process, therefore, is probably the best and only requires to be perfected for our own use.

Photo-collotype.

105. When I was last in Europe, 10 years ago, the photo-collotype was almost unknown. Since then it has come largely into use in most countries in Europe for printing all kinds of photographic illustrations. It does not, however, appear to have been made much use of for the reproduction of maps in Government establishments.

106. I am sorry that I did not see so much as I could have wished of the working in Europe of this process, with which I have experimented so much myself in this country; but my attention was more particularly directed to the engraving processes which I believe to be more valuable for purposes of the office, and as the collotype processes are worked almost entirely by professionals, I was not likely to get any detailed information regarding them. I

was interested, however, to find that the process used at the Military Geogr[illegible] Vienna was very similar to that by which my earliest attempts at collotype were [illegible] it might be worth trying again.

Other photographic processes.

107. The only two other photographic processes I saw that were worthy of special note were the platinum-printing process and the simple pigment process used at the Depôt de la Guerre, Paris. Both these processes can, I believe, be utilised to considerable extent in the office; the first for ordinary photographs in half-tones, such as views, &c., and the second for line work.

Electrotyping and steel-facing.

108. As the introduction of my method of photo-engraving for reproducing the sheets of the Atlas of India would involve the necessity of making proper arrangements for electrotyping and steel-facing on moderately large scale, I paid particular attention to the different kinds of apparatus used for this purpose in order to find out which could best be adopted here.

109. I found several systems of electrotyping in use, but am inclined to prefer a single cell apparatus which, to my knowledge, has been in use for the last 10 years in the Military Geographical Institute at Vienna, or, if this should not be found to answer, the system in use at the Depôt de la Guerre, Paris, *i. e.*, Clamond's piles and deposition of two plates with a single anode in a separate trough, might be tried,

110. For steel-facing I found Smee's batteries almost universally used, but I believe that a small dynamo-electric machine could be usefully employed for this purpose in this country, and could further be utilised in nickel-plating if set up in the Mathematical Instrument Department, where there would probably be spare engine-power to work it.

Extract from the Narrative Report, dated 13th January 1879, of J. B. N. HENNESSEY, ESQ., *M. A., Deputy Superintendent, 1st Grade, in charge, Head-Quarters Offices, Trigonometrical Branch, Dehra Dun.*

COMPUTING BRANCH.

Calculating Branch.

2. The following cost table of work done in the Computing Branch is similar to the one exhibited last year:—

Cost table in Rupees, 1877-78.

CLASSES.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Average per cent.
1. Records, Library	68	84	61	196	208	69	35	22	44	104	95	125	4
2. Computations	247	240	146	74	396	89	92	325	390	272	266	348	11½
3. Accounts, Returns, Correspondence	294	193	224	296	233	250	209	276	406	375	636	332	14
4. Supply	77	70	19	45	70	23	39	105	36	81	31	46	2½
5. Press copy	661	467	424	421	344	328	410	475	602	581	384	514	23½
6. Press proofs	401	335	309	341	379	337	452	378	321	334	368	369	17
7. Charts	55	22	29	17	55	24	26	56	59	44	25	26	2
8. Stations	34	17	55	88	106	71	67	124	69	151	83	90	3½
9. Leave, Holiday	61	380	663	357	151	309	597	223	30	2	166	104	12
10. Meteorology, Miscellaneous	229	320	197	307	199	142	215	208	205	188	193	238	10
	2,127	2,127	2,127	2,142	2,142	2,142	2,142	2,192	2,162	2,132	2,167	2,192	100

The above table agrees practically in the column "Average per cent." with the similar table given last year, excepting in classes 2 and 5; these, however, are so intimately connected with one another, that it is often very difficult for a computor to allot certain prices of his work to one of the classes in preference to allotting it to the other. For purposes of comparison, the figures under classes 2 and 5 should be taken *collectively*.

Calculating branch, particulars of work.

3. Particulars of the work generally indicated in the preceding table are as follows for each class:—

4. *Class 1. Records, Library.*—A considerable quantity of field and other records has been suitably rough bound, indexed and labelled, thereby greatly promoting not only facility of reference to these records, but their safety as well. No less than 218 volumes have been thus satisfactorily disposed of, and they moreover now occupy probably less than half the storage space before required for them.

5. *Class 2. Computations.*—

N. W. QUADRILATERAL, JODHPORE SERIES.—Simultaneous reduction continued, with the given equations of condition to the end.

N. E. QUADRILATERAL BUDHON SERIES.—Simultaneous reduction revised, owing to introduction of two additional equations of condition.

Principal Triangulation in general (in duplicate.)

Triangles, computed or corrected	170
Latitudes, longitudes and azimuths, computed, single deductions ...	31
Ditto ditto ditto 2nd „ ...	100
Reduction of simple figures, computed	3
Ditto compound ditto	3
Auxiliary figures (final) computed	13
Azimuths (astronomical) examined	1
Ditto ditto partly computed	2

Secondary Triangulation in general (in duplicate.)

Traverses computed	15
Triangles computed and adjusted	800
Latitudes, longitudes and azimuths, computed or corrected	1,300

with much miscellaneous work in addition to the foregoing.

6. *Class 3. Accounts, Returns, Correspondence.*—These duties have somewhat increased.

—Data in manuscript have been supplied to 19 of[illegible] [illegible]ps, charts, forms and books have been made. In addition, tab[illegible] [illegible] Clarke, showing the astronomical latitude and the geodetical elements for all the stations where latitude had been observed; also, a table of geodetical elements for all the longitude stations.

8. *Class 5. Press Copy*—prepared.

VOLUME 2.—All the tables included in Chapters XVII and XVIII, Appendices 8 to 11 and part of 12.

N. W. QUADRILATERAL, JODHPORE SERIES.—Lists, descriptions, observed angles, reduction of figures, principal triangles, heights and astronomical azimuths: secondary triangles, azimuths and co-ordinate lists; also tabular statements to illustrate account of simultaneous reduction.

Ditto VOLUME IV.—Certain pages recast, and tables of errata and addenda revised.

Ditto SYNOPTICAL VOLUME VII.—Tables of contents, title, references and errata; also, orthography of proper names occurring in part of the introduction examined.

S. E. QUADRILATERAL, EAST COAST SERIES.—Co-ordinate list, name list (chiefly for use in drawing office), and addendum to description of principal stations.

Ditto JUBBULPORE, BIDER AND BILASPUR SERIES.—Furnished with introductions; and the first of these series, as well as the Great Arc (section 18° to 24°), furnished with preface, contents, and errata table. Also, addendum to description of principal stations for the Great Arc (section 18° to 24°), Jubbulpore, Bider, and Calcutta longitudinal series.

Ditto SOUTH PARASNATH AND SOUTH MALUNCHA SERIES.—Lists, descriptions, observed angles, reduction of figures, triangles and heights; also azimuths, co-ordinate and name lists, and tabular statements to illustrate simultaneous reduction.

N. E. QUADRILATERAL.—Heights and descriptions of spirit levelled points completed owing to the improvements in the form in which these are exhibited, the portion reported last year as ready required considerable amendment.

Ditto. BUDHON SERIES.—Reduction of figures, principal triangles, and synopsis of latitude, longitude, and azimuth.

Ditto. CACHAR BRANCH SERIES.—As for Budhon Series.

Ditto. EASTERN FRONTIER SERIES.—Descriptions of stations.

Ditto. AMUA SERIES.—Addendum to descriptions.

Ditto. Astronomical azimuths for the entire quadrilateral.

Ditto. GURWANI, GORA, HURILAONG, CHENDWAR, CALCUTTA MERIDIONAL AND N. E. LONGITUDINAL SERIES.—Orthography of principal stations revised in keeping with Government lists.

Ditto. BUDHON, AMNA, KARARA, GORA, HURILAONG, CHENDWAR, North MALUNCHA, North PARASNATH SERIES.—Triangles, azimuths, co-ordinate and name lists.

In addition to the foregoing, the spirit levels taken in Mangalore were put up for press; these and the several pamphlets of levels in the North-Western Provinces and Oudh and Bengal were furnished with introductions. Plates of figures for entire North-Eastern Quadrilateral were prepared for fair drawing.

9. *Class 6. Press Proofs.*—Details of this subject are far too voluminous for exhibition here; they occupied no less than 17 per cent. of the whole working power of the office, exactly as last year.

Stations.—Examined or compared—

	Name.	No. of Stations.
Preliminary.	Thayetmyo and Cape Negrais Triangulation, season 1876-77 ...	1
	Thayetmyo and Tounghoo ditto ditto ...	1
	Eastern Sind Series, season 1876-77	1
	Index to sheets of the Cutch Survey	1
Final ...	Great Arc Series, section 18° to 24°, No. 1	1
	Calcutta Longitudinal Series, Nos. 1, 2, 3	3
	East Coast Series, Nos. 1 and 2	2
	Bider Series	1
	Jubbulpore Series	1
	Bilaspur Series, No. 2	1
	South Maluncha Series	1
	South Parasnath Series	1

In addition to the foregoing, 8 plates shewing figures on 8 series of the N.-E. Quadrilateral (for illustrating professional volumes of this quadrilateral) were examined.

11. *Class 8. Stations.*—Twelve additional duplicate lists completed, making a total of 335 settled districts accounting for 3,100 principal stations, and leaving about 15 districts yet to be settled. Six new lists, accounting for 46 stations, and 15 duplicate or supplementary lists descriptive of 90 stations supplied to district officials.

12. *Class 10. Miscellaneous.—Meteorological* observations taken twice daily on every day of the year at Dehra, and for 5 months at Mussoorie. Results for Dehra and anemograms for both Dehra and Mussoorie supplied to the Meteorological Reporter to the Government of India; and weather telegrams supplied daily for Mussoorie, July to September. *Time*—47 sets (on 16 days) of observations to the sun taken and reduced. Stock taken of all Ordnance and sundry stores, and the stores carefully arranged. Also, stock taken as usual in the other branch offices, *viz.*, Computing, Drawing, Photozincographing, and Printing. Translations (from the vernacular) made of several traverses by explorers. Quarterly List of Maps and Charts published at Dehra supplied to the Surveyor-General's Office, Calcutta; and copies of printed papers periodically arranged and despatched to the same office for safe custody. Three candidates for the junior branch of the Survey Department examined, &c. &c.

Typographic Branch.

13. The work annually performed by this branch during the past five years is briefly given in the following table, where the unit (a page) is the same throughout:—

	1873-74.	1874-75.	1875-76.	1876-77.	1877-78.
Pages composed	1,220	1,319*	1,179*	1,535*	2,050
,, printed	388,420	372,647*	349,000*	495,573*	630,894

The considerable increase in the amount of work executed by this branch is chiefly due to the vigorous efforts made by the whole office to comply with the orders received for completing the publication of volume II.

The total pages composed during the year under report may be sub-divided thus —

For Volume II and its Appendices	670
,, N.-W. Quadrilateral and its Supplementary Volume	197
,, S.-E. ,, Professional and Synoptical Volumes	228
,, N.-E. ,, ,, Volumes	731
,, Pamphlets of Spirit-levelled Heights	68
,, Charts, Memoranda, &c.	156
TOTAL ...	2,050

The progress made to date towards publishing the results of the Great Trigonometrical Survey of India may be briefly stated thus:—Professional Volume I, published; Professional Volume II, approaching completion: of N.-W. Quadrilateral Professional Volumes III and IV are ready for issue; Synoptical Volumes I to VI published, VII nearly ready; Jodhpore Series, well advanced: of S.-E. Quadrilatera, Professional Volume VI, approaching completion; Synoptical Volumes VIII to XIII nearly ready; South Maluncha and South Parasnath Series in hand: of N.-E. Quadrilateral all the 16 series are well advanced in respect of Professional Volumes, and Synoptical Volume of 1 series is in hand.

* Averages for a twelve-month.

Photozincographing Branch.

The following are details of the work executed by this branch :—

MAPS.

Subject.	When published.	Number of parts.	Number of copies printed.
Prints of maps published in former years		53	1694
Guzerat Survey, Sheet No. 14, Section 5	October 1877	1	84
" " " 14, " 8	" "	1	86
Index to Kattywar Survey	" "	1	458
" to Guzerat "	" "	1	450
" to Level Charts	November "	1	447
" to the Triangulation of India	" "	1	491
Guzerat Survey, Sheet No. 78, Section 1	" "	1	85
" " " 78, " 3	" "	1	86
" " " 78	" "	1	185
Dehra Dun and Siwalik Survey, Sheet No. XL	" "	1	109
" " " " XXXIV	December "	1	143
Guzerat Survey, Sheet No. 79	" "	1	193
" " " 79, Section 1	" "	1	87
" " " 78 " 2	" "	1	88
Kattywar Survey, Sheet No. 46	" "	1	135
Map of the Kumaun Lakes (*For Geological Survey*)	" "	1	821
Dehra Dun and Siwatik Survey, Sheet No. XXXIII	January 1878	1	140
Guzerat Survey, Sheet No. 14, Section 10	" "	1	89
" " " 79, " 2	" "	1	90
" " " 79, " 3	" "	1	91
Deoban Forest Map No. 1 (*For Forest Department*)	" "	1	78
Kumaun and Garhwal, Sheet No. 20, contoured	February "	1	110
Guzerat Survey, Sheet No. 80	" "	1	129
" " " 14, Section 12	" "	1	85
Deoban Forest Map No. 2 (*For Forest Department*)	" "	1	77
Dehra Dun and Siwalik Survey, Sheet No. XXXVI	" "	1	138
" " " XXIX	" "	1	140
" " " XXVIII	" "	1	138
Kumaun and Garhwal, Sheet No. 11, contoured	March "	1	106
" " " 19 "	" "	1	112
Kattywar Survey, Sheet No. 47	" "	1	129
" " " 48	" "	1	132
Dehra Dun and Siwalik Survey, Sheet No. XXIV	" "	1	141
" " " XXXVII	" "	1	156
" " " XXXI	April "	1	142
Deoban Forest Map No. 3, (*For Forest Department*)	" "	1	83
Spirit-levelling Operations, No. 53	" "	1	253
" " 59	" "	1	261
Kumaun and Garhwal, Sheet No. 27, contoured	" "	1	112
Guzerat Survey, Sheet No. 81	" "	1	132
" " " 82	" "	1	143
" " " 30	May "	1	182
Kumaun and Garhwal, Sheet No. 28, contoured	" "	1	108
" " " 30, "	" "	1	107
Dehra Dun and Siwalik Survey, Sheet No. XXIII	" "	1	144
" " " XXXII	" "	1	149
" " " XXXVIII	" "	1	140
" " " XXXIX	" "	1	138
" " " XLIII	" "	1	147
Guzerat Survey, Sheet 29	June "	1	183
Kumaun and Garhwal *Forest* Map, Sheet No. 32 } (*For Forest Department.*)	July "	1	81
" " " 33 }	" "	1	60
" " Sheet No. 31, contoured	" "	1	113
" " " 36 "	August "	1	110
Map of Cyprus, French	" "	1	97
" English	" "	1	90
Guzerat Survey, Sheet No. 31	September "	1	128
" " " 31, Section 1	" "	1	85
Index to Guzerat Survey (*Revised*)	" "	1	475
" Kumaun and Garhwal Forest Survey (*For Forest Department*)	" "	1	205
" Dehra Dun and Siwalik Survey	" "	1	205
Charduar Caoutchouc Plantation, Block No. 1, (*For Forest Department*)	" "	1	660
Mysore, illustrative of the Famine (*For Famine Commission*) ...	" "	1	25
TOTAL ...		116	12,481

Besides the following, 195 blue-prints were issued, and 426 sets of silver-prints (120 subjects) were prepared for the use of the engravers and for Executive Officers.

CHARTS.

Subject.	When published.	No. of parts.	No. of copies printed.
Bilaspur Meridional Series, No. 1 ... ... Final	November 1877	1	386
" " " " 2 ... ... "	December "	1	371
Madras Coast Series, Season 1876-77 ... ... Numerical	January 1878	1	70
Great Arc Meridional Series, section 18° to 24°, No. 1 ... Final	" "	1	369
" " " 18° to 24°, No. 2 ... "	" "	1	372
Jubbulpore Meridional Series ... ... "	February "	1	370
Reduction Chart of the S. E. Quadrilateral ... ... "	" "	1	311
South Parasnath Meridional Series ... ... "	" "	1	375
" Maluncha " ... ... "	" "	1	385
Thayetmyo and Cape Negrais Triangulation (secondary), Season 1876-77 ... ... Numerical	" "	1	73
Calcutta longitudinal Series, Nos. 1 and 2 ... ... Final	March "	1	402
" " No. 3 ... ... "	" "	1	411
Thayetmyo and Tounghoo Triangulation (secondary), Season 1876-77 ... ... Numerical	" "	1	60
Eastern Frontier Series, Season 1876-77 ... ... "	" "	1	66
Bider Series, Nos. 1 and 2 ... ... Final	April "	1	437
Eastern Sind Series, Season 1876-77 ... ... Numerical	" "	1	73
TOTAL ...	... ...	16	4,531

DIAGRAMS.

Subject.	When published.	No. of copies printed.
Polygons and other figures to illustrate figural reductions for volumes of the Great Trigonometrical Survey, Bench Marks, &c.	October 1877	1,072
	November "	80
	December "	716
	March 1878	110
	April "	1,233
	June "	740
	July "	754
	August "	172
TOTAL ...	... ...	4,877
Professional and Office Forms	1877-78	23,736

Contrasting the work performed since 1873-74, we have—

Year.	Maps.	Blue-prints.	Silver-prints.	Charts.	Diagrams.	Forms.
1873-74	9,207	53	Not reckoned	2,027	3,557	28,125
1874-75	7,040*	20*	... ...	3,015*	3,701*	24,219*
1875-76	14,025	12	126	1,678	9,722	18,314
1876-77	12,348	108	189	9,225	3,956	21,384
1877-78	12,481	195	426	4,531	4,877	23,736

An abstract of the work executed during the past five years stands thus—

Subject.	Number of Prints.				
	1873-74.	1874-75.	1875-76.	1876-77.	1877-78.
Maps, Charts, and Diagrams	14,791	13,756*	25,425	25,529	21,889
Blue-prints and Sliver-prints	Not reckoned	Not reckoned	138	297	621
Forms	28,125	24,219*	18,314	21,384	23,736

* Averages for a twelve month

Drawing Branch.

The principal work performed in this branch during the 12 months ending 30th September 1878 is detailed in the following table :—

Description of work.	No. of Sheets or Diagrams.		Scale 1 inch=	Remarks.
	Finished.	In hand.		
Compilation.			Miles.	
Sheet No. 53 of spirit-levelled Heights	1	...	2	For photozincography.
„ No. 59 of „ „	1	...	2	
„ No. 1 Dehra Dun and Siwáliks (corrected)	...	1	1	
„ No 2 „ „	...	1	1	
Map of Turkestan (4th edition, revised and enlarged)	...	4	32	
„ of Routes in the Punjab, Kashmir, and N. W. P. (revised edition)	...	1	32	For use of engravers.
Map of explorations from Darjeeling by the Kangra Lamba Pass eastwards into Great Tibet	...	1	8	For photozincography.
Diagram of S. E. Quadrilateral (for illustrating synoptical volumes)	1	...	125	
„ of N. E. Quadrilateral „ „ ...	1	...	125	
Charts illustrating the reduction of the N. E. Quadrilateral ...	...	1	12	
Serial chart of the minor mountain triangulation executed by the Kashmir Survey and N. W. Himalaya Series (for illustrating synoptical volume)	1	...	8	
Diagram, of figures of the N. E. Quadrilateral (for illustrating prof. volumes)	12	...	6	
Final Charts.				
Bider Longitudinal Series	2	....	4	For photozincography.
Calcutta „ „	3	...	4	
Jubbulpore Meridional „	2	...	4	
East Coast Series	2	...	4	
South Maluncha „	1	...	4	
„ Parasnáth „	1	...	4	
Budhon Meridl. „ (principal triangulation)	...	1	4	
Ampa „ „ „ „	...	1	4	
North Parasnáth Meridl. Series (principal triangulation) ...	...	1	4	
Gora Meridl. Series „ „ „	...	1	4	
Preliminary Numerical Charts.				
Eastern Sind Series, season 1876-77.	1	...	4	
Miscellaneous.				
Examined and reported on 28 fair original maps of Kumaun and Garhwal, Kattywar, Guzerat, Dehra Dun and Siwalik Surveys ...	...	...	...	
Examined proofs of all maps and charts published during the year...	...	...	...	
Colored 6,938 maps...	...	...	..	
Rendered fit for photozincography 4 numerical charts drawn by field parties	...	...	...	
Made drawings, and drew up descriptions of bench-marks for sheets Nos. 53 and 59 of spirit-levelled heights.	...	...	...	
Prepared additional manuscript tables of routes for pamphlet of routes	...	...	...	
Corrected and added to Map of India (scale 1 inch = 32 miles) for Surveyor-General's Office, Calcutta	...	...	...	
Transliterated names on Russian maps for employment in new (4th) edition of Turkestan map	...	...	...	
Translated Abdool Wahad Explorer's field book, and prepared rough traverses of his work	...	...	...	
Extended graticule of the Maps of Persia	...	...	...	
Prepared numerous tracings and pantographic reductions for employment in compilations and for issue to officers, and drew 4 forms for photozincography	...	...	...	
Preparing new "Stock List" of maps, charts, &c.	...	...	...	

Meteorological results.

16. Tables of the monthly meteorological results are herewith appended as usual.

Monthly Meteorological results taken from the Register kept at the Head-Quarters Office, Trigonometrical Branch Survey of India, Dehra Dun.

Year and Month.	Barometer.						Hygrometer.				Thermometer.								Rain.		Wind.	Clou	
	At 9 h. 30 m., a. m.			At 3 h. 30 m., p. m.			At 9 h. 30 m., a. m.		At 3 h. 30 m., p. m.		Dry Bulb.					Wet Bulb.							
	Highest.	Lowest.	Monthly mean.	Highest.	Lowest.	Monthly mean.	Monthly mean temperature of Dew Point.	Monthly mean humidity.	Monthly mean temperature of Dew Point.	Monthly mean humidity	Maximum in sun's rays.	Minimum on grass.	Maximum in air.	Minimum in air.	Monthly mean in air.	Maximum wet.	Minimum wet.	Monthly mean wet.	No. of days it fell.	Fall in inches.	Most frequent direction.	At 9 h. 30 m., a. m.	At 3 h. 30 m., p. m.
1877.																							
November	27·905	27·698	27·806	27·604	27·494	27·703	52·7	·572	52·6	·431	97·0	43·6	84·3	47·3	67·0	73·0	43·4	56·6	1	0·23	N. N. E.	2	3
December	·912	·672	·810	·789	·570	·718	48·6	·743	49·8	·589	85·0	34·8	73·5	38·2	58·3	61·5	36·6	50·5	8	4·00	N. N. E.	5	6
1878.																							
January	·972	·591	·817	·855	·530	·735	45·8	·798	46·3	·568	76·0	30·1	67·7	35·0	53·4	59·1	33·7	47·2	4	2·70	W. S. W.	4	5
February	·879	·693	·795	·807	·631	·720	50·4	·771	57·5	·706	84·1	39·0	78·5	44·5	59·4	62·0	39·7	51·6	8	2·21	N.	5	6
March	·848	·513	·727	·760	·422	·654	53·3	·581	53·7	·430	103·1	39·9	91·0	44·0	68·0	71·2	43·0	55·2	3	1·26	N. N. E.	2	3
April	·771	·538	·646	·677	·447	·572	61·5	·615	62·9	·528	107·0	46·0	92·2	50·3	74·6	77·1	48·5	60·3	7	3·33	N. N. E.	4	5
May	·631	·517	·572	·568	·445	·495	61·6	·601	60·9	·492	106·3	53·0	92·8	56·0	75·2	73·2	50·5	64·0	12	4·80	N. N. E.	5	6
June	·557	·296	·415	·489	·197	·324	65·5	·468	62·3	·326	117·4	62·0	106·5	66·3	87·4	80·1	57·3	68·7	3	·68	N. N. E.	1	
July	·507	·346	·430	·426	·277	·360	75·1	·803	75·4	·683	109·5	66·5	96·0	70·1	82·1	81·9	63·4	73·4	22	25·49	S. S. W.	6	
August	·641	·344	·581	·530	·268	·408	74·8	·876	76·3	·813	105·0	70·0	90·7	70·8	79·6	81·0	62·4	72·5	26	21·07	S. S. E.	8	
September	·685	·325	·526	·581	·270	·432	72·7	·799	74·3	·729	104·0	64·0	88·7	65·8	79·0	86·0	61·0	72·5	17	15·05	S. E.	4	

Note.—The height of the Barometer Cistern above mean sea-level at Karáchi is 7232·41 feet.

e winds which blew at Dehra Dun during
for each hour of the day.

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
0 to 1 ...	2·80	2·74	2·19	1·58	2·18	3·79	3·30	1·94	2·00	1·33	0·79	0·68
1 „ 2 ...	2·53	2·53	2·15	1·68	1·68	3·21	2·93	1·58	1·20	1·26	0·79	0·33
2 „ 3 ...	2·50	2·58	2·30	1·71	2·11	2·52	2·56	1·55	0·80	1·04	0·86	0·73
3 „ 4 ...	2·07	2·37	2·19	1·71	2·21	2·03	2·52	1·71	0·80	1·52	0·69	0·63
4 „ 5 ...	2·07	2·42	1·78	1·65	1·86	2·14	1·93	1·58	1·20	1·44	0·52	0·50
5 „ 6 ...	1·73	2·05	1·70	1·87	1·79	2·07	1·96	1·45	1·20	1·33	0·59	0·43
6 „ 7 ...	1·70	1·95	1·89	1·77	1·68	2·14	1·57	1·10	0·40	0·78	0·66	0·47
7 „ 8 ...	1·53	1·79	1·85	1·42	1·86	1·59	1·21	1·29	0·80	0·81	0·66	0·27
8 „ 9 ...	1·07	1·79	1·59	1·06	1·64	1·45	1·75	1·90	0·80	1·30	0·83	0·40
9 „ 10 ...	1·50	1·68	2·15	1·58	1·93	1·45	1·96	2·55	1·00	1·41	0·86	0·73
10 „ 11 ...	2·07	1·68	1·89	1·94	2·18	2·07	2·46	2·74	1·40	1·36	1·17	1·03
11 „ 12 ...	2·23	2·21	2·23	2·16	2·71	2·28	3·07	3·26	2·20	1·68	1·75	1·40
12 „ 13 ...	3·24	2·85	2·16	2·58	2·82	3·11	3·93	4·23	3·25	1·96	1·59	1·30
13 „ 14 ...	2·17	3·00	2·69	2·43	3·00	2·93	4·04	3·84	3·00	2·24	1·52	1·67
14 „ 15 ...	2·52	3·25	2·58	2·87	3·07	3·86	4·00	3·45	4·25	2·38	1·48	1·53
15 „ 16 ...	2·34	2·40	2·12	2·77	3·07	3·59	4·10	2·97	3·25	2·00	2·34	1·30
16 „ 17 ...	1·55	1·15	1·33	2·16	3·14	3·10	2·79	2·97	3·25	1·75	1·03	1·00
17 „ 18 ...	0·62	1·10	1·15	0·87	1·39	1·90	2·10	2·45	2·25	1·04	0·79	0·93
18 „ 19 ...	1·72	2·00	1·41	0·45	1·25	0·97	2·03	2·23	0·50	0·71	0·52	0·37
19 „ 20 ...	2·69	2·55	1·41	0·65	2·00	2·14	3·00	2·32	0·25	0·57	0·69	0·43
20 „ 21 ...	3·31	3·00	1·78	1·26	1·93	3·17	4·07	2·90	2·25	0·75	0·72	0·53
21 „ 22 ...	3·21	3·05	2·19	1·58	2·46	3·17	3·50	2·39	3·00	0·96	1·00	0·93
22 „ 23 ...	3·31	3·35	1·93	1·71	2·32	3·38	3·68	2·32	1·75	1·54	1·14	1·13
23 „ 24 ...	3·14	2·90	2·15	1·68	2·25	3·93	3·39	1·65	1·75	1·21	1·07	0·87
Sums ...	53·62	56·39	47·11	41·14	52·53	61·99	67·85	56·37	44·55	32·37	24·06	19·54
Average ...	2·23	2·35	1·96	1·71	2·19	2·58	2·83	2·35	1·86	1·35	1·00	0·81

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